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PAG BULLETIN

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COVER:

Mealtime for farm family in Hokkaido region of Japan. (United Nations photo.)

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Twenty-third PAG meeting

This year's meeting of the PAG was held at WHO headquarters in Geneva from 4 to 10 June. Participating were PAG members and consultants, representatives of various U.N. agencies—including those sponsoring the PAG, and representatives of bilateral agencies of several governments. A list of participants appears below.

During the meeting, WHO Director-General Dr. Halfdan Mahler joined the discussions. In introducing him, PAG Chairman Dr. Joaquín Cravioto outlined the trend of the discussions. He noted that although problems and programs in both food and health have been receiving deserved attention from the U.N. agencies and governments, the importance of nutrition as a crucial element that actually links the two areas has received relatively little attention and low priority. He hoped the results of the World Food Conference and the current interest of U.N. agencies and governments in nutrition may afford new opportunities for purposeful and effective action by the PAG.

In response, Dr. Mahler agreed with Dr. Cravioto and noted that frustration over nutritional progress is general. As for nutritionists, he pointed out that what they do and advise results in little social benefit largely owing to a widespread belief that medicine, health, food and nutrition are independent rather than interwoven threads in the social fabric.

He went on to say that that belief is a hangover from the past, and unless it is soon reappraised in the context of today's changing events, nutritionists and others who have traditionally operated along narrow lines of specialization will fail. A new and rapidly evolving outlook on health and nutrition now has political and financial backing. This should encourage the disciplines to shed their cramped shells of specialization and endeavor to enter broader fields of human activity.

Indeed, action in nutrition and health should be taken *by* the people themselves and not *for* them by those who call themselves experts. This is a difficult change to bring about but it is worth the effort. The route laid out by traditional nutritionists and physicians is not the best, and new situations require new remedies.

Asking the PAG not to yield to frustration, Dr. Mahler expressed gratification that the group is willing to undertake new risks and challenges. He wished the PAG success in its new efforts.

Food marketing and nutrition

The primary agenda item was food marketing policies for improving human nutrition. PAG Secretary Mr. Jacobo Schatan introduced the topic stating that the main purpose was to emphasize the nutritional significance of food marketing in the complex chain of events leading from production to consumption. This importance was not recognized until recently, and awareness of it is still not widespread. Mr. Schatan stressed the need to find solutions to the many problems found in the marketing process and which most particularly affect the poorer segments of society. Toward this end he hoped the discussions would help arrive at minimum guidelines to identify what should be taken into account when establishing sound food policies. These would include pricing policies and improved food delivery programs to benefit the poorest and most vulnerable population groups.

The discussions focussed on several issues raised in background papers: the concept of social marketing and its relationship to general socioeconomic development and planning within different political structures; problems of delivery, particularly to needy population groups; price and subsidy policies and their effect on food consumption and nutritional levels, including the use of food as a means of payment. Many of these issues recurred as the group discussed case studies in Bangladesh, India, Indonesia, Thailand, the People's Republic of China, the United States and in particular the experience of CONASUPO in Mexico, which was dealt with in some detail.

Food marketing in most countries is in the private sector and aimed at maximizing profits. The concept of social marketing is gaining ground in a number of countries because large portions of the population are poorly fed, due in part to inadequate or inefficient marketing systems. Increasingly, but at varying rates and depths, governments are intervening to purchase, process and sell food products directly to consumers.

Government intervention in some form appears necessary for adequately injecting nutritional aims into the marketing process, which should be considered in its own right part of the wider socioeconomic development process. The group felt that governments should exert increased efforts, for example in promoting producer, consumer and other types of cooperatives, particularly in view of the urgent need to build up efficient marketing management techniques and skills in such enterprises. Cooperative marketing for input and output of agricultural products as well as for consumer goods, should play an increasing role.

Such marketing systems could improve nutrition in two ways. One is by making the system more efficient through a reduction of food spoilage, lowering of food prices by more efficient operations, and direction of activities toward appropriate target groups. Examples were given where food prices were reduced between 15 and 20 per cent through improved marketing methods and organization. The other way is to make use of the marketing approach to strengthen nutrition programs. Modern marketing techniques could play an important role, particularly for identifying target consumers, choice of strategy, market sgementation and operation of a dual pricing system.

It was pointed out that social marketing systems already exist in rural areas of certain countries but are gradually being replaced by profit-motivated wholesale marketing. There was general recognition that marketing devices motivated solely by commercial considerations can have a negative effect on nutrition. Thus it was felt that not only should the trend toward commercialization be arrested but further that major steps be taken to introduce the notion of nutritional objectives as a social concept and an essential element in both rural and urban food marketing. Such objectives include *a.* stimulating internal food production through appropriate pricing policies; *b.* development of built-in mechanisms for providing employment and needed purchasing power to low income groups; *c.* movement towards income redistribution; *d.* assistance in reducing malnutrition among the vulnerable groups in the population.

That existing traditional rural agricultural markets should be oriented towards nutritional goals was considered particularly important since in many countries much of the food is produced in small rural units which are also foci of malnutrition. In such areas producers' and consumers' cooperatives could incorporate improved post-harvest technology, storage, transportation and other methods aimed at increasing small farmers' real incomes and raising their levels of food consumption. In these ways rural populations would become able to sell produce at higher prices and

purchase essential consumer goods at lower prices. In addition, such programs would include purchase of agricultural inputs and would thereby lower production costs and increase real incomes.

It was recognized that rural income redistribution cannot come through price systems alone, despite their importance. Lack of purchasing power precludes taking advantage even of inexpensive food no matter how low the price. Steps will have to be initiated along with improved marketing arrangements for providing employment, perhaps along the lines of employment guarantee schemes for skilled and unskilled labor such as practiced in parts of India. The use of food as money equivalent in payment of wages to landless labor as well as in lieu of land revenue and other taxes also deserves examination. Comprehensive rural development programs must also include purchase of produce from small farmers by the state or other agencies, along with an entire range of technical, organizational and other measures that would aim to improve the farmers' output and enlarge the local market system.

Although government policies and programs aimed directly at reducing prices and increasing purchasing power are primary in any overall marketing scheme, it should be recognized that an entire range of interventions and supporting programs could be employed. Examples include establishment of government marketing organizations, government facility services such as marketing development centers for research, training and demonstration as well as measures for promoting and regulating competition, as appropriate. Governments can also influence marketing by regulating specific marketing functions in addition to pricing, such as transportation rates, weights and measures, packaging regulations, food standards and so on.

The choice of overall schemes depends on given marketing situations. In emergency situations, the main objective is to achieve a fair distribution of limited food supplies to all of the people; the design of effective rationing systems, including dual pricing systems is essential. This approach would often include food for work programs to stimulate employment. In more normal times nutrition improvement programs would be of a long-range nature, including identification of nutrition gaps within countries and regions, income groups, age groups, etc., with a set of policies for overcoming these gaps.

It was agreed that in order to bring about many of the necessary changes in marketing systems, personnel trained in market management would be needed. At present there is a shortage of such people, and training today aims more at profit making than at social objectives, not to mention nutritional objectives. To make these changes and overcome resistance to them will require considerable research.

The discussion then turned to nutritional problems that would not be automatically solved by social marketing. Steps would have to be taken to remove the bias in redistribution that usually favors urban population groups. Intrafamily maldistribution would have to be met by special programs such as feeding mothers and young children, school lunch programs and similar activities. In order to have a full nutritional impact, along with social marketing the elements of consumer education and purchasing power creation are important concommitants.

Finally, the group acknowledged that marketing must be an integrated system within a much broader scheme of economic and social development. Isolated measures may solve problems in restricted cases or regions. A more permanent overall solution to hunger and malnutrition would be a combination of measures such as price fluctuation controls, buffer food stocks, special distribution of food, increased food production and means for stimulating demand.

PAG role in identifying applied nutrition research priorities and evaluating interventions

The PAG addressed itself to the need for an international program of applied nutrition research, specifically in reference to Resolution V of the World Food Conference. The relevant paragraph of the resolution asks FAO, WHO and UNICEF "to arrange for an internationally coordinated program in applied nutritional research to include establishing priorities, identifying appropriate research centers and generating the necessary funding."

For assigning priorities in applied nutrition research, it was felt that topmost would go to gaps in knowledge that impede decision making. These are not merely gaps in data, rather they are gaps in problem assessment and in operational procedures specific to a given situation or to application of strategies.

The members observed that the PAG could play a useful role in this important work. They also proposed the establishment of three standing committees to perform the technical work of the PAG as follows:

• *Committee One—Policy and Planning.* An example of a policy issue this committee might examine is price policy and nutrition.

• *Committee Two—Projects and Programs: Identification, Design and Appraisal.* Examples of project issues this committee might deal with are the relationship between hunger and school performance and the effects of improved water supply on growth, development, morbidity and mortality of preschool children.

• *Committee Three—Food, Agriculture and Health: Scientific and Technological Issues.* Examples of issues this committee might deal with are effects of iron and/or calorie supplementation on human performance and the effects of calorie and/or protein supplementation on the outcome of pregnancy.

Criteria for choosing the specific topics to be tackled by such committees would be *a.* whether the lack of information on the proposed topic is significantly impeding the ability to correct the conditions of malnutrition; *b.* whether the information to be generated is of critical importance to nutrition problem solving in a country-specific context; *c.* whether the information generated by the proposed research could be extended to more general conditions and to other regions; and *d.* the degree of importance of the program, strategy or target in terms of number of persons affected, relevance to governmental investment, sustained nature of improvements, etc.

Other business

Additional items discussed at the meeting included reports on important recent nutrition-related developments in the fields of the participants. These ranged from laboratory research results to notes on innovative nutrition programs. In addition, a brief summary was given on the MIT project that is compiling a world inventory of world protein and energy resources [see News]. The representatives of agencies sponsoring PAG briefly described follow-up action taken by their agencies in response to World Food Conference recommendations. Short reports were also given on recent United Nations agency and interagency meetings that had dealt with nutrition issues. Also, the future direction and organization of the PAG were discussed, and a tentative program of work was recommended.

Participants

PAG members. Joaquín Cravioto (*Chairman*), Mexico; Sol Chafkin, U.S.A.; Joseph H. Hulse, Canada; Leonard Joy, U.K.; Karl E. Knutsson, Sweden; Asok Mitra, India; N.S. Scrimshaw (*ex officio*), U.S.A.; Selo Soemardjan, Indonesia; Thomas Stapleton, Australia; and M.S. Swaminathan (*Vice-chairman*), India. (Julian Chacel, Brazil; Jean Mayer, U.S.A.; and Million Neqniq, Ethiopia were unable to participate in this meeting.)

Consultants. Doris H. Calloway, U.S.A.; Carmen Hamann, Brazil; Enrique Diaz Ballesteros, Mexico; Enrique Ríos, Mexico.

United Nations agencies. FAO: Paul Lunven and Hans J. Mittendorf; IAEA: Robert Rabson; UN/ESA: Hans Einhaus; UNDP: Arturo Chávez; UNICEF: L.J. Teply and Alan Robinson; IBRD (World Bank): Alan Berg; WHO: M. Béhar and E.M. DeMaeyer; PAG Secretariat: Jacobo Schatan and P.S. Venkatachalam.

Bilateral agencies. DANIDA: Mogens Jul and Jørgen H. Jensen; NORAD: Sverre Lie and Wenche Eide; SIDA: Elisabeth Michanek and Bo Wickstrom; USAID: Martin J. Forman.

Breast-feeding in family planning

*Franz W. Rosa**

In tropical areas, breast-feeding is indispensable for the nutrition and survival of infants. Although this in itself is important for the acceptance of family planning, it is not fully recognized that lactation plays a direct and major role in moderating fertility in developing countries. It is important to relate contraception to breast-feeding so that the two can be used together for greatest effect.

Although breast-feeding generally prolongs the delay in the return of menstruation following delivery, this does not represent complete protection from ovulation. A recent careful study found that the majority of women ovulate just prior to the resumption of menstruation (*7*). In various studies, from three to 15 per cent of pregnancies have been found to occur with no sign of menses since the previous birth. Fertility protection from lactation beyond the amenorrheal period is totally unreliable. One-half of the women in typical developing areas become pregnant while lactating—often with disasterous effects for the weanling—and most will become pregnant even if they continue breast-feeding.

Estimate of protection from lactation amenorrhea

Data on the degree of fertility protection provided by breast-feeding was recently reviewed (*15*); Table I (*10*) reproduced here expands the area studies. Although the data are still imperfect, especially for rural areas, it is estimated that breast-feeding prolongs birth interval by about four months on the average in urban areas and about eight months in rural areas.

The prolongation varies widely however, reaching an extreme of almost 18 months in rural Java (*14*), Bangladesh (*2*) and Rwanda (*1*); on the other hand it is much less, for example, in some areas of Latin America.

Certain other variables related to both breast-feeding and fertility must also be considered. Frequency of exposure to coitus during the breast-feeding period varies; prolonged lack of exposure in polygamous areas with taboos on intercourse may be a factor in the birth interval. Differences in levels of education and employment in women who breast-feed appear to be a moderate factor. The duration of breast-feeding, postpartum amenorrhea and birth interval increases with maternal age. Supplemental infant feeding substantially reduces the duration of postpartum amenorrhea. The duration is greater in rural areas, probably due chiefly to more prolonged breast-feeding. It is also prolonged in mothers with severe nutritional depletion. The amenorrhea in poorly-nourished women who are further depleted by the substantial nutritional demands of breast-feeding could more rightly be described as lactation-starvation amenorrhea. Psychosocial and other cultural factors may also play an important role.

In the developing countries (excluding the People's Republic of China, N. Korea, N. Vietnam and Cuba) with a total population of 1838 million, approximately one-fourth live in urban areas. Based on 75 per cent breast-feeding in urban areas, an average urban birth rate of 30 per 1000, and an average of four months additional protection from breast-feeding, the annual number of couple-years protection from breast-feeding in urban areas is 3.4 million.

In the remaining three-fourths of the population, which is rural, based on 85 per cent breast-feeding, an average birth rate of 40, and an average of eight months additional birth interval prolongation, 31.3 million couple-years of protection is attained. The total protection for both urban and rural areas thus comes to 34.7 million couple-years of protection annually.

Compared to this, the total couples protected from contraceptive methods provided by voluntary as well as official family planning programs, at the beginning of

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* *Dr. Rosa is director of the school of public health and professor of maternal and child health at the American University of Beirut, Lebanon. This paper was written while he was a consultant to the United Nations Fund for Population Activities. The views expressed here are Dr. Rosa's and do not necessarily coincide with those of the UNFPA or PAG.*

TABLE I. COUNTRY DATA ON LACTATION, POSTPARTUM AMENORRHEA, CONCEPTION INTERVAL*

Area and year		Sample †	Lactation		Amenorrhea (No. months)		Conception interval ‡ (No. months)	
			% Start	Months (mean)	Lactating	Non-lactating	Lactating	Non-lactating
AFRICA								
Algeria	'71	8000 UR		17.6				
Egypt, Cairo	'68	300 U		15.1	6.0			
Egypt, Cairo	'60	282 U			5.3	2.0		
Ethiopia, Tigre	'64	162 R		20.0				
Ethiopia, Sidamo	'64	154 R		15.0				
Ethiopia, Arussi	'64	214 R		9.0				
Gambia	'67	44 R		22.0				
Nigeria, Ibadan	'74	480 U	100	16.0				
Nigeria, Imassi	'64	291 R	100	23.0			26.5	8.0
Rwanda	'74	235 U		9.0	9.0		11.7	5.6
Rwanda	'74	601 R		24.0			28.8	8.9
Senegal	'71	8500 R		24.0	11.0		23.9	10.7
Tanzania	'66	RL			18.0			
Tanzania	'66	RH			9.0			
Zaire	'60			16.4	10.8			
ASIA								
Bangladesh, Matlab	'74 &'72	200 R	100	25.0	18.9	2.0		
India, Baroda	'71	H			6.0			
India, Baroda	'71	L			18.0			
India, Bombay	'58	272 U			12.0			
India, Bombay	'57	523 U		16.5	11.9			
India, Bombay	'67				6.0			
India, Calcutta	'71	2225 U	93	16.6	9.0	3.0		
India, Tamil Nadu	'73	3000 R		22.2	14.4	1.9		
India, Maharashtra	'57	488 R			13.5			
India, Punjab	'59	1400 R	98	21.0	10.8			
India, Ramanagram	'54				11.0			
India, Singur	'60 -'63	936 R		28.0	18.0			
India, U.P.	'66	2500 R			13.0			
Jordan	'65		95	16.0				
Lebanon	'65	379 UL	97	10.0				
Philippines, Manila	'74	501	77	10.2	6.8	3.4	20.1	15.8
Philippines, four towns	'74	309 U	79		8.5	3.5	20.3	16.9
Philippines, Manila	'65	100 U	83	11.0				
Philippines, Luzon	'65	150 R	89	19.0				

Philippines, Luzon §	'73	165 R	90	12.3	9.8	1.9		
Indonesia, Mojolama	'74	2195 R	99	25.6	22.1	5.1	28.7	
Cocos-Keeling Islands							21.5	7.9
South Korea	'68	1900 UR	96	24.0	15.0			
South Korea, Seoul	'72	335 U	80		6.0	3.9		
South Korea, Sungdong Go	'72	139 R	92		12.0	4.4		
South Korea	'72	600 U	95	20.0	12.5			
South Korea	'72	375 R	97	27.7	15.3			
Taiwan	'70 &'72	1175 U	88	14.0	9.7	3.5		
Taiwan	'70 &'72	1516 R	96	17.7	11.4			
Thailand §	'69	1600 U	84	12.0	6.6	2.9		
Thailand	'72	600 R	98	24.0				
Thailand	'72	700 R	85	16.0				
Turkey, Ankara §	'68 - '69	400 U	95	13.0	6.2	4.4		
West Irian	'67		100	54.0			53.0	6.0
AMERICAS								
Chile, Santiago	'71	154 U	75	3.7	3.8	1.6		
Chile	'69 -'70	1900 R	68	6.0				
Colombia, Medallin	'68	2000	79	5.5				
Guatemala	'63	Ladino U		13.0				
Guatemala	'63	Ladino R		15.0				
Guatemala	'63	Indian R		30.0				
Jamaica	'70	300 U	95	6.0				
Martinique	'70	900 R		10.3				
St. Vincent	'71	300		9.6				
Venezuela, Colombia§	'68 -'69	1100 U	82	7.6	2.3			
Canada, Eskimos	'71			30.0			25.0	3.0
Canada, James Bay Indians	'40		31	15.0				
Canada, James Bay Indians	'60		5	5.0				
Alaska, Eskimos	'71	116 R			10.0	3.2		
Guatemala, Catarinecos, Highland Indian	'71	75 R		24.0	12.0		17.0	7.0

** Due to space restrictions, references to data sources have been omitted; this information may be obtained on request from the author. (Source: Reference 10.)*

† R = Rural; U = Urban; H = High economic group(s); L = Low economic group(s)

‡ Interval from delivery to next conception.

§ IUD follow-up study.

1974, has been calculated to be 24 million (*11*). Thus in developing countries approximately one-third more protection is provided by lactation amenorrhea than by family planning program contraceptive methods.

The degree of protection from lactation amenorrhea is undoubtedly decreasing because of reduced breast-feeding, increased bottle feeding and supplementation, urbanization, "modernization", the increased availability of canned milks, and unfortunately all too often from poor medical and nursing guidance (*6*). These changes have been dramatically documented in the Eskimos and native Indians of Canada and Alaska. Data on James Bay Indians show that the increase in bottle feeding and the decrease in the average duration of breast-feeding from fifteen to five months between 1940 and 1960 appeared to be an important factor in the reduced birth interval (*8*). In another study the main factor leading to an increase of the birth rate from 40 to 64 among Canadian Eskimos was reported to be the introduction of bottle feeding (*13*). The increase in birth rate could even be correlated with the proximity to the nearest trading center providing canned milk!

On the other hand, the continuation of a high level of traditional breast-feeding during the early stages of the demographic transition may lead to a reduction in birth rate, because with falling infant mortality rates the mothers are increasingly protected by breast-feeding the surviving infants (*5*).

Specific suggestions

What are the practical implications of the above observations? First it should be made clear that promotion of breast-feeding as an alternative to contraception is neither practical nor wise. Pregnancies that intervene during breast-feeding—usually after menstruation has returned—are especially hazardous for the nursing infant, and therefore *it turns out that*

TABLE II. LACTATION VS. FAMILY PLANNING PROGRAMS: RELATIVE PROTECTION IN DEVELOPING COUNTRIES* , 1973

A. Lactation

Area	Population	Total births (estimated)	Breast-fed †	Average prolongation of birth interval	Resulting couple-years protection
Rural	1, 378, 000,000	55, 100, 000	85%	8 months	31, 300, 000
Urban	460, 000,000	13, 800, 000	75%	4 months	3, 400, 000
TOTAL	1, 838, 000,000				34, 700, 000

B. Family Planning Programs (Official and Voluntary)

Method	Cumulative total new acceptors through 1973	Resulting couple-years protection from continuing users 1973
Pill	11, 500, 000	3, 800, 000
IUD	17, 000, 000	5, 400, 000
Sterilization	15, 700, 000	11, 000, 000
Other	19, 300, 000	3, 800, 000
TOTAL couple years protection		24, 000, 000

* *Excluding People's Republic of China, North Korea, North Viet Nam and Cuba.*

† *Reduced for estimated infant non-survival.*

breast-feeding should be considered more as an argument in favor of contraception than as an alternative contraceptive method. Furthermore, whatever birth spacing that does occur from prolonged breast-feeding in less developed countries is generally associated with poor maternal nutritional status resulting from the drain on the mother caused by repeated pregnancies and breast-feeding unaccompanied by improvement in the diet. This depletion in turn can lead to fetal undernutrition with long-term developmental implications for the child (*9*). Nevertheless, everything possible should be done to reverse the present trends away from breast-feeding, not only because of its influence on fertility but also because of its importance to infant development and survival.

The following suggestions would appear to be useful for improving the interaction between breast-feeding and family planning:

1. With expanding oral contraceptive programs it is important both for pill acceptance, as well as for continuation of breast-feeding, to clarify the biological, psychosocial, and programmatic interrelations between these factors. Most studies of the impact of the pill on lactation indicate that lactation is reduced with estrogen-containing pills (*3, 12*). Few of these studies are on a controlled double-bind basis that would make possible the separation of hormonal influences from suggestive influences; the latter are well-known to be capable of reducing lactation. Programatically, there is uncertainty over when to commence the pill in breast-feeding mothers. Many programs recommend postponing the pill for a few months until breast-feeding is "well established", until supplemental feeding is introduced, or even until menstruation resumes. The major disadvantage is that a substantial proportion of women fail to return to the clinic or center to start the pill. Some women get pregnant before they can be started on the pill. Other programs therefore recommend starting the pill on a postpartum basis or at any time they are prepared to start. This not only endangers infant nutrition, but may even eliminate the birth spacing effect of breast-feeding should the women discontinue the pill. Worst of all, a few places are instructing the mothers to discontinue breast-feeding when they start on the pill. This is likely to cause widespread nonacceptance of the pill by women who want to breast-feed; where it is accepted, and given prevailing rates of discontinuation, there will likely be less prevention of births than were the women to have been allowed to continue breast-feeding.

Currently, these questions are acutely important because of recent plans and proposals to expand pill distribution widely, either on a clinical or non-clinical basis, in large populations that have heretofore not been supplied with the pill.

2. Breast-feeding can be a most useful motivation for women to accept contraception. Women in these areas do not want to get pregnant while they are breast-feeding. The health worker should first reassure and support the mother about the desirability of breast-feeding and then immediately remind her, "Of course you don't want to get pregnant while you are breast-feeding, do you?" This can lead to a higher rate of acceptance than any other approach, and is the least controversial. Women are often more interested in protecting their present baby than in preventing the next.

Incidentally, when the mother does not want to breast-feed, the health worker's follow-up can be, "Of course if you don't breast-feed you are likely to get pregnant again right away, unless you accept some precaution," in order to motivate for postpartum acceptance.

3. Awareness on the part of national and family planners of the enormous role breast-feeding can play in preventing births could be the means for increasing the heretofore inadequate concern of public health workers for combatting commercial promotion of artificial feeding. Such commercial promotion is widespread in many parts of the world and uses means such as posters, provision of free introductory samples of bottles and formulas, sales visits to maternity services, provision of midwifery bags advertising their products, and subsidizing the bulk of professional medical meetings held in developing countries. In many areas this exceeds the effort exerted in promoting family planning.

4. In developing countries, especially in urban areas, a principal reason for not breast-feeding is employment of mothers. The provision of creches in industries and markets could obviate some of this, both to the benefit of infant health and family planning. Reports indicate

that the People's Republic of China has widely applied this approach with success.

5. This issue should be emphasized, and health and family planning workers should be instructed accordingly.

6. Maternity services in developing countries should always be designed so as to encourage breast-feeding, principally through rooming-in of the newborn with the mothers. Unfortunately many of the expanding services that are now being developed are imitating the unfortunate pattern of the western countries. Rooming-in is more acceptable to the mothers, more convenient for the hospital staff, quieter and healthier for the babies—despite the many imaginary objections that are voiced by misguided health workers. The benefits have been dramatically confirmed in those hospitals that have been convinced to switch from nursery care to rooming-in.

7. In maternity services there is no justification for the widespread practice of providing a bottle "until the breast comes in". Provision of this alternative has an unfortunate influence on the mothers' breast-feeding ability, both psychologically and physiologically. For thousands of years babies got along well and still do in many areas where bottles are not available. For both health and family planning it is important to get the mothers off to the right start.

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Nutrition, mother's health and fertility: the effects of childbearing on health and nutrition

*Samuel M. Wishik and Susan Van der Vynckt**

Introduction

There is fundamental concern throughout the world regarding the widespread failure of the development process to reach the people most in need. Governments and international agencies are hard at work to treat the chronic problems of underdevelopment: disease, rapid population growth, malnutrition, illiteracy, underemployment and inadequate food resources. However, planners are only just beginning to realize that if they persist in attacking each problem in isolation, the progress that can be made toward the common goal of all intervention programs — improvement of the quality of life — will be limited.

The whole is the job. Piecemeal efforts not only can fail to reach their short-term and long-term goals but may even become counterproductive. Thus, reducing infant mortality through improved health and nutrition may on the one hand immediately mean more mouths for the family to feed and more persons to house and clothe, yet on the other hand, merely reducing the numbers of births will not ensure that children will survive nor will it make education accessible to them.

Health, nutrition and fertility interact in a complex way that determines the well-being of the family. Heretofore, attempts at improvement have concentrated on separate symptoms rather than on the complexes within which symptoms interact. Programs in each of the areas share the common goal of family well-being; integrated efforts for program promotion would therefore appear to be most logical.

The problem

Industrially developed countries have all attained low birth rates, a status gained through the well-known three stages of demographic transition: first, high mortality and high birth rates; then, lowered mortality with continuing high fertility and consequent rapid population growth; finally, low fertility and low mortality. It is generally accepted that countries that are now in the first and second stages will eventually reach the third in conjunction with improved literacy, standard of living and general development. The questions at issue are the time it will take, whether that time can be shortened and how to shorten it.

Most of the less developed countries do not face mere recapitulation of the history of demographic transition. Their present circumstances are different; they already have achieved a large population base and are now under pressure to close rapidly the gap between themselves and more advanced countries. They must telescope the time it takes to achieve higher socioeconomic status with slower population growth, while in the interim they receive support and collaboration from other nations.

The interim should be a period of expanded education, health promotion, nutrition improvement and lower fertility. Such betterments come from the society combined with action on the part of the individual. Prominently, the latter efforts are aimed towards sounder individual dietary practices and fertility behavior. The least a society should provide its families should be the options for wholesome eating and for individual control of fertility.

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* *Division of social and administrative sciences, International Institute for the Study of Human Reproduction, Columbia University, New York.* *Edited version of background paper for the World Population Conference, Bucharest, August 1974, United Nations document E/CONF. 60/BP/4. The conference background papers are collected in* The population debate: dimensions and perspectives, *United Nations sales publication 75, XIII.2, Vol. I. (In press). Present paper published with the kind permission of the population division of the United Nations department of Economic and Social Affairs.*

This paper explores whether those two options can be made more accessible, acceptable and attractive by an integrated nutrition-fertility approach. We contend that nutrition intervention without fertility modification, or fertility modification without concern for nutrition, can have only limited success. In fact we deem such programs probably to be scientifically questionable, socially unreasonable and programatically ineffective — even in the short term. Joint nutrition promotion and fertility modification programs are essential. For the longer term, impact on the larger development goals may be far greater if the programs are integrated from the start.

Fertility as insurance against child loss

Social demographers and others have long believed that acceptance of family planning in developing countries will not occur until a significant reduction in infant mortality has been achieved (*1*). This "child survival hypothesis" states that once child loss rates decline, parents will perceive that fewer pregnancies are necessary to guarantee desired family size. If more children are surviving, the initital effect is increased family size and population growth (*2*). The theory postulates that in a later period the population growth rate will decrease due to purposeful fertility control by parents. This hypothesis must be tested on a large scale in order to identify the time lag between attainment of increased infant and child survival and the lowered fertility rates that come with the awareness that increased family size is a limitation (*3*).

The implication of the child survival hypothesis is that program intervention should proceed first by improving the state of health and nutrition, which will enhance survival chances, continue with family planning education to make women aware that fewer pregnancies are possible and then proceed to the offering of the means to control unwanted pregnancies. Such a simplistic palliative is subject to two seemingly opposite criticisms, which however do not deny the basic importance of infant mortality in the overall question. One criticism is the obvious fact that a mere excess of children over the family's capacity to care for them has not prevented marginal societies from having extremely high fertility. The key is not simply an awareness of the disadvantages of excessive family size, but the additional awareness of the contradictions of the situation when there is opportunity for the family's betterment. This opportunity must be real and visible. Among most deprived peasantry of the world, the family with three children is hardly less hungry than the neighboring family with ten. Moreover, housing in the rural areas seems to have an inexhaustible capacity to absorb families as they grow. A strong element of social and economic improvement is an essential tile in the mosaic of program intervention. Research is needed to find out just how purposeful is lowered fertility behavior and to understand the dynamic sequence of motivational change at different levels of deprivation and opportunity in relation to different risks of child loss.

A second and apparently opposite criticism contends that infant mortality is what shortens lactation, vitiates cultural taboos against abstinence and places women in a continuous state of reproductive effort. Thus this explanation is without the need for a psychological or motivational interpretation at the family level. In effect, the very concept of protecting the pregnancy-free interval tends to disappear and the changed attitude carries over even to the time when a more fortunate surviving infant is in need of care. The physiological elements of this model and its nutritional implications will be considered at length below.

Basic relationships between nutrition, health and fertility

The relationships between nutrition and fertility are interactive and cyclic. This causes difficulties in attempting to delineate the direction of cause and effect and to measure discrete components in the complex interrelationships. Even in a simplified analysis, two directions must be considered and an attempt made to dissect the elements which constitute the effects of nutrition upon fertility and the effects of fertility upon nutrition.

Effects of nutrition upon fertility. Nutritionists have long studied the effects of a woman's nutritional status upon the likelihood of conception and the course and outcome of pregnancy; they have produced a rich literature on it (*4*). Serious complications of pregnancy, delivery and the period after delivery can be attributed to nutritional aberrations of women during pregnancy (*5*). Congenital malformations, birth weight, constitutional strength, defenses against disease, growth and development and chance of survival among

the offspring may be modified by the mother's prenatal nutritional status (*5*).

Effects of fertility upon nutrition. This paper deals primarily with the opposite side of the nutrition/fertility relationship: the question, "How does fertility — the frequency, timing and circumstances of childbearing — affect the nutrition both of women and their offspring and therefore the life and health of all of them?" For this purpose, it is necessary for the analysis to bear in mind constantly the all-pervading socioeconomic determinants and also to raise certain still somewhat theoretical questions regarding the variable physiological readiness of women to meet the physical demands of pregnancy and childbirth at different points in their childbearing years. The interplay between theoretical considerations and actual experience has implications for program intervention.

Pregnancy during the post-adolescent years. As for the span of childbearing years, possible instances of "excess fertility" might be expressed as: "too soon, too late and too many". "Too soon" refers to the post-adolescent overlap when pregnancy intervenes before the woman has reached what may be her optimum age for childbearing. The unfavorable mortality and morbidity statistics among such young mothers and their children have been evident at all times and in all places. Those outcomes have been assumed to be due to endocrinologic and anatomic immaturity with respect to reproduction, coupled with the many nutritional demands of continuing growth and pregnancy.

It is clear, however, that the phenomenon is not entirely physiological. In the more developed countries childbirth among women in their late teens is becoming less and less hazardous. On the other hand, in the poorly developed countries a greater maternity risk below age twenty persists (*6*). The differences may reflect better obstetrical care as well as general socioeconomic improvement. In a study by one of the present authors (*7*) in Hawaii thirty years ago, first births among the youngest groups of mothers age fifteen to twenty when analyzed according to pregnancies in and out of wedlock revealed a three-fold differential in pregnancy wastage after the first trimester and a seven-fold differential in obtainment of minimum reasonable prenatal care. Thus the social definition of "illegitimacy" carried built-in roadblocks to access to health-care resources.

This problem is particularly relevant in less developed countries because of the characteristic earlier age of marriage and first pregnancy. It is not uncommon for the extended family to count the months that elapse between a consummated alliance and a pregnancy in order to prove the bride's worth. In some cultures pregnancy is a precondition to marriage, just as it so often leads to marriages for legitimization in westernized societies. In the latter, there have occurred a dramatic secular trend to earlier menarche and a recent tendency to earlier marriage and first birth among some groups. No matter the bases, the importance of giving special attention to the nutritional improvement of adolescent girls in all countries cannot be overemphasized. Policy and program efforts must thus devise effective ways to delay the age of first pregnancy; the ways must be culturally appropriate and societally feasible.

Pregnancy during the pre-menopausal years. The term "too late" applies at the other end of the childbearing years and refers to the contention that conception continues to take place past the optimum age for mother and child. No finding is more consistent that the correlation of pregnancy complications and unfavorable outcomes with advanced maternal age. The hazards associated with premenopausal pregnancies are universally recognized.

The question of "too late" is closely tied to the problem of "too many", since the highest parity orders must cluster at the later years. Advanced age and high parity add risk, even taken separately; together, the jeopardy is compounded (*6*). The findings of a number of studies on the dangers of high parity deserve mention, although it has not always been possible to separate out interrelated variables, such as age, in the research designs. Women of higher parity are more prone to anemia (*8*) and lower weight: height ratios (*9*). Children in larger families, especially with more preschool-age children, or of higher birth order, suffer more from malnutrition, grow more slowly, are more anemic (*10*), more likely to have impaired mental development (*11*) and are offered diets lower in calories and protein and which use less per capita expenditure (*12*). Socioeconomic differentials admittedly correlate with the higher parity and consequently with the greater

FIGURE 1. PREGNANCY WASTAGE RATES

A. Less developed countries.
B. Better developed countries.

frequency of unfavorable sequelae. How much does the disadvantage stem from parity and how much from economic deprivation? Some data on this will be given below. To some extent, the offending agent must be some combination of the constituent factors. Figure 1. compares the high pregnancy-wastage rates in many less developed countries with the low rates in the more favored countries. Apart from the greater wastage in the less developed countries at all parities — and implicitly in all age groups — the U-shaped curve is deeper, showing distinctly greater hazards in the higher parities.

The lessons are clear; the health and nutrition of mothers at the upper end of their childbearing years or of parity need special protection so long as complete avoidance of pregnancy is not assured at those ages. The goal of contraceptive protection in these groups of women would seem to be a reasonable concurrent target. The large majority of these women have attained or exceeded their desired family size, and they are not expected or required by the family to produce more offspring, nor is their hierarchical status dependent on continued childbearing. Many a woman is ready to settle into an abstinence relationship with her husband if permitted and even welcomes or encourages other sexual outlets for him, such as concubinage and prostitution. The pressures to seek such alternatives, which can lead to possible or at times implicit social dislocations, might be lessened by greater access to acceptable and reliable contraception. For the older age groups, surgical sterilization is an obvious solution that warrants emphasis in fertility modification programs.

Close birth spacing. The problem of "too close together" must be added to the list of fertility excesses thus far discussed. Recent thinking rejects the traditional concept that pregnancy constitutes a stress upon the woman's usual physiology similar to the effect of disease. Rather, the position is held that a woman adjusts to a new physiological state that includes herself, the fetus and the placenta. These pregnancy-related physiological changes must be reversed after delivery through a process of readjustment. In general, the readjustment seems to be a fairly prompt response to the restored hormonal balance after delivery. This is not surprising on teleological grounds; one would expect that reverse adjustment in the healthy postpartum woman ought to be reasonably complete in time for the next pregnancy. Overlap between incomplete restoration and a succeeding pregnancy is by definition undesirable. This situation could result from delay of the normal readjustment or failure to respect the "natural" interval between pregnancies or both (*13*).

The interval between pregnancies has two parts; these constitute the pregnancy-free period before and after the postpartum return of ovulation. Compared with the state that prevailed among earlier socieites, the "natural" interval is today being shortened first by replacing breast-feeding with artificial feeding of infants (*14*), thus reducing the effect that lactation has in delaying the return of ovulation, (*15*); second, by a weakening of cultural taboos against postpartum sexual intercourse. Both developments are widespread concomitants of the urbanization and industrialization that accompany rapid population growth in less developed countries. The total interval between conceptions is further shortened by abortions and miscarriages and by fetal and early infant deaths, which remove the need for breast-feeding.

More and more data are accumulating on the undesirability of very short interbirth intervals (*16*). They substantiate the same belief, nearly worldwide, among earlier societies. Peoples in parts of Africa and

elsewhere have in their languages a word, such as one meaning "mutual poisoning", to denote the incompatibility between the baby at the breast and the one growing in the womb.

Oddly, this proposition is difficult to prove. Often the reported interbirth intervals disguise unidentified interrupted pregnancies, and such data produce inverted paradoxical conclusions. However, recent studies have been more successful than earlier ones in allowing for socioeconomic class differences that confer common and parallel effects upon fertility behavior, nutrition, health and survival (*17*).

The "normal" interbirth interval of earlier societies that would result from a nine-month, full-term pregnancy plus the anovulatory state during full breast-feeding (six to nine months or more) plus abstinence (another fifteen months) equals two-and-one-half to three years. To a healthy woman living under favorable conditions, an interval shorter than this may not be threatening. For less healthy women in poverty and under other environmental stresses, what otherwise may have been a physiologically permissible interval becomes too short.

Program efforts must aim at maintaining a safe interbirth interval. To avoid shortening of gestation, better nutrition before and during pregnancy is needed, as well as selective, focused antepartum health supervision and care. To prevent shortening of the anovulatory period, infant survival must be assured by various means: health and nutritional protection, educational campaigns on the benefits of breast-feeding that are directed at countering commercial pressures toward artificial feeding, and government policies and programs that affect the employment roles of women and enhance the opportunities for mothers to remain with and care for their nursing infants.

To prevent shortening of the anovultory period, access to effective contraception is the modern equivalent to postpartum cultural taboos. An associated need is the nutritional protection of nursing mothers and of young children, at least through the post-weaning period.

Two different sets of hypotheses can be posited with respect to the impact of the length of interbirth interval on a given index child, according to whether the interval being studied preceded or followed its birth. Giving consideration to the total pregnancy history of the mother and working backward from the index child's birth, one is concerned with the course of the prgnancy during intrauterine residence, the mother's health and environmental stresses during the pregnancy-free interval between its birth and that of the next older sibling, the length of that interval, the occurrence of lactation during that time, and the nature of the earlier pregnancy and its sequelae. On the other hand, working forward across the interval that followed birth, one must again include the mother's experience during the index child's embryologic and fetal development, the birth and postpartum course, whether the infant was breast-fed, its subsequent diet and illnesses and the time elapsed before the mother conceived again. The pregnancies on both ends of the interval under analysis as well as the events during that interval must be weighted when evaluating the data.

Although the mother's full pregnancy and health history is relevant, we have arbitrarily chosen to focus on the proximate three- and five-year periods for intensive quantitative analysis and have developed several indices called fertility burdens (*18*). These constitute the bases for classification and statistical comparisons among groupings of women and their children. The indices are being continually checked for validity. They are:

a. Gestation burden: the number of months of pregnancy weighted by trimesters of pregnancy;

b. Lactation burden: the number the months of lactation weighted by proximity to delivery and extent of supplementation of the infant's diet;

c. Gestation/lactation burden;

d. Child care burden: the number of child-years among the siblings during the interval under analysis weighted by the ages of the children;

e. Family food consumption burden: the number of family members weighted by age and sex.

Work is also in progress for devising improved health and socioeconomic indices suitable for such studies.

Findings indicate that interbirth interval, as measured

directly and as manifested indirectly in women's age-specific parity, correlates significantly with the probability that their young children will achieve better growth and development and nutritional state (*19*).

Of course, age-specific parity is largely a reflection of spacing. Direct measurement of birth interval also reveals very interesting and important health relationships. Women whose birth intervals fall at or below two years are less likely to have well-nourished children. At higher parity, it takes an interval of almost three years for the children to have a reasonable chance for adequate nutritional status in generally deprived populations (*20*).

Conclusion

Because of the essential interdependence of fertility modification and nutrition promotion in achieving their common goals of better family health and welfare, it is recommended that integrated public programs be established. Information on the bases for such a coordinated attack should be disseminated widely.

Pilot intervention programs should include experimental and control populations in several countries that together represent a reasonable spectrum of levels of development. A common evaluation system should be built in with appropriate adaptations according to country. Allowing for a planning and development period of two years, the prospective span of the pilot program should start showing results in three years and would be clearly interpretable in five.

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PAG *ad hoc* working group meeting on clinical evaluation and acceptable nucleic acid levels of SCP for human consumption

This PAG meeting was held at WHO headquarters, Geneva, 6 and 7 February 1975.

Participants

Working group members. Prof. Nevin S. Schrimshaw (*Chairman*), Head, Department of Nutrition and Food Science, Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A.; Prof. Andre de Vries, Director, Rogoff-Wellcome Medical Research Institute, Beilinson Hospital, Petah Tikvah, Israel; Prof. Richard W.E. Watts, Head, Division of Inherited and Metabolic Diseases, Clinical Research Centre, Harrow, U.K.; Prof. James B. Wyngaarden, Chairman, Department of Medicine, Duke University School of Medicine, Durham, North Carolina, U.S.A.; and Prof. Nepomuk Zöllner, Medizinische Poliklinik der Universitat München, Munich, Federal Republic of Germany.

United Nations agencies. FAO: G. Kapsiotis. WHO: M. Béhar and E.M. DeMaeyer. UNICEF: L.J. Teply. PAG Secretariat: P.S. Venkatachalam.

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The report of the meeting was submitted under two sections as follows:

1. ACCEPTABLE LIMITS OF NUCLEIC ACID IN SCP FOR VARIOUS AGE GROUPS AND DIET PATTERNS

1.1 Uricogenic agents in single cell protein products and uric acid metabolism

Sources of purines in the diet consist of ribonucleic acid (RNA) deoxyribonucleic acid (DNA) and nucleotides. The term "nucleic acids" is general, and its use may lead to the assumption that the ingestion of purines from any source gives rise to the same increase of plasma uric acid concentration and urinary uric acid excretion.

This indeed is not the case. RNA, the predominant source of purines in SCP products, produces an increase of urinary uric acid of 100 to 150 mg/g RNA, which means that only part of the purines in this nucleic acid is absorbed and eventually excreted as uric acid by the kidney. The ratio between RNA administered and uric acid excreted appears to be constant over an entire range, up to exretion values of 1750 mg/day. In a range up to 4g RNA ingested there is also a proportional rise in plasma uric acid, amounting to 0.9 mg per 100 ml per g RNA administered per day. On the other hand, if there should be increased hydrolysis of RNA prior to or immediately after ingestion, the response to RNA may possibly become exaggerated.

The effect of DNA on uric acid levels in both urine and plasma is about half of that of RNA. The effect of ingested nucleotides is larger and may yield uric acid excretion levels that indicate complete absorption of purines from such sources. Levels of uric acid excretion related to total nucleic acid intake should most closely parallel results with RNA alone. If there is an appreciable proportion of DNA, calculations based on RNA only will overestimate the production of uric acid.

In SCP products, RNA is the predominant uricogenic agent, followed by DNA, with nucleotides constituting only a minor fraction. The chemical identity of the purines in the ingested ribonucleic acids reflects their origin but does not influence plasma and urinary uric acid levels. For example, the effects of feeding adenylic and guanylic acid are usually identical.

The statements made above are generally applicable to healthy young male volunteers. Much less information is available on the response in females; preliminary experiments indicate that increases in plasma uric acid are smaller. Data are lacking for infants and children. There is a small group of persons in the apparently healthy population who show larger increases in uric acid concentration in plasma although the response of urinary uric acid excretion at all dose levels investigated is the same as that of the rest of the population.

1.2 Purine nitrogen versus protein nitrogen in SCP products

Since substantial parts of the total nitrogen in SCP products may come from nucleic acid, the calculation of "crude protein" by multiplying total nitrogen by 6.25 produces a serious overestimate of protein and therefore an underestimate of the proportion of nucleic acid relative to protein. For proper calculations, purine nitrogen must be determined separately and the nucleic acid content calculated using appropriate methods.

Also to be taken into account is the pyrimidine nitrogen of nucleic acids. Since the nitrogen content of pyrimidines is about 40 per cent that of purines and both are present in equimolecular amounts in most nucleic acids, the purine nitrogen should be multiplied by the factor 1.4 in order to obtain nucleic acid nitrogen. A "corrected protein nitrogen" (still containing nitrogen from lipids and polysaccharides) is obtained by subtracting 1.4 times purine nitrogen from crude protein nitrogen.

Multipling by the proper factors (6.25 for protein, 9.0 for nucleic acids from purine nitrogen) the values for "corrected protein" and "nucleic acids" are obtained.

1.2.1 *Sample calculation*

Given:

Total nitrogen content of sample of SCP product from yeast = 1000 mg
Purine nitrogen = 160 mg (by analysis)
"Protein nitrogen" = 840 mg
Ratio purine N: protein N = 1:5.25

Calculate:

Total nucleic acid N = 160 x 1.4 = 224 mg
Corrected protein N = 1000 mg — 224 mg = 776 mg

Ratio total nucleic acid N: protein N = 1:3.5

Crude protein content = 1000 x 6.25 = 6250 mg

"Protein content" after excluding purine N = 840 x 6.25 = 5250 mg
Corrected protein content = 776 x 6.25 = 4850 mg

Total nucleic acids = 224 x 9 = 2016 mg.

Obviously, it should be stated explicitly in all cases how values given were derived. It is suggested that "corrected protein" values should be compared with nucleic acid values. Results given as total nitrogen and as purine nitrogen tend to understate the case. It should be mentioned that when eating conventional mixed diets the ratio of nucleic acid nitrogen to protein nitrogen will be very much lower than the 1:3.5 given in the example above.

1.3 Hyperuricemia and hyperuric aciduria — clinical implications

1.3.1 *Applicability of data.* The relationship between dietary nucleic acid consumption and blood levels and urinary excretion of uric acid are relevant to an analysis of the present problem.

The existing information on uric acid levels in blood and urine in relation to the diet has been derived from studies on populations consuming Western European or North American diets. It is doubtful if this type of diet is the most suitable from the viewpoint of avoiding pathological changes due to hyperuricemia or hyperuric aciduria. Where the pre-existing diet is based on legumes, the purine load is likely to be of the same order as that arising from the more varied Western diets. Nevertheless the application of data obtained from these studies to regions where dietary protein and energy deficiency are known to exist in large segments of the populations requires detailed background information on the relevant environmental and genetic factors, including the prevalent morbidity pattern. The possible risks on the basis of the suggested association between hyperuricemia, and hypertension, obesity, hypertriglyceridemia, atherosclerosis and diabetes melitus must be viewed in this context.

1.3.2 *Clinical manifestations.* The clinical conditions reported to occur in hyperuricemia are gout, hyperuricemic nephropathy and renal stones. Their occurrence depends on the degree and duration of the hyperuricemia, although the quantitative effects of both factors have not been precisely defined. The best data available are those which relate to a population of Framingham, Mass., U.S. (*5*). The results of this twelve-year survey are given in Table I below. Also included in the table are values from a study conducted in France (*10*).

1.3.3 *Factors influencing uric acid levels.* Several factors in addition to diet influence uric acid levels in blood and urine. (See Appendix.) Some of these are sex, obesity, ingestion of alcohol and some drugs, dehydration and urinary tract infection.

TABLE I. PREVALENCE OF GOUT IN MALES, RELATED TO SERUM URATE CONCENTRATION AND AGE (*5,10*).

Serum urate concentration	Mean age 49	Mean age 58
7.0 - 7.9	4.7%	16%
8.0 - 8.9	11.4%	25%
9.0 - 9.9	31.6%	90%
10 or above	47.6%	

Such data are not available for nephropathy and renal stones, but their association with hyperuricemia is well established (2,3,4,6,8,9).

The mean serum urate concentration is similar in both sexes during childhood; but levels rise at puberty, more in males than in females. At menopause the levels rise further in females, approximating those found in males. In population studies, gout has been found to be statistically associated with obesity. Similarly a correlation of hyperuricemia with alcohol ingestion has been observed. A number of drugs commonly used have been reported to cause hyperuricemia. The risk of renal uric acid stones is greater whenever the urine secretion is lowered and the urine pH is acidic. The mechanism of action of urinary tract infection seems to be through reducing fluid intake and diminishing urine volume.

There is also evidence for genetic differences among populations. Population groups with hyperuricemia not attributable to dietary or other factors listed above, have been identified.

1.3.4 *Permissible level of serum uric acid.* According to Zöllner and Griebsch (*11*), feeding 1.0g daily of RNA per 70kg body weight increased serum uric acid by 0.9 mg per cent in subjects who are taking a purine-free diet. The working group recommends that serum uric acid levels should not be allowed to exceed 8mg/100ml. It is an accepted clinical practice not to treat hyperuricemia in the absence of clinical manifestations unless it reaches the 9.0mg/100 ml level.

PAG Guideline No. 12, *Production of single cell protein for human consumption*, has proposed a maximum amount of 2g of nucleic acid per day as safe practical limit for most adult populations. By making the *unfavorable* assumption that this is all RNA, the serum uric acid would rise by only 1.8 mg/100ml. On subjects fed yeast containing 2g nucleic acid the rise in serum uric acid was well within acceptable levels (*1*, *7*). That is, it did not carry an appreciable risk of gouty arthritis.

1.3.5 *Permissible level of urine uric acids.* The consequences of uric acid lithiasis are considered more serious than those of gouty arthritis. Hyperuric aciduria is an important factor in the etiology of uric acid lithiasis. Other known contributory factors are low urine volume and low urine pH. The role of other urinary constituents responsible for the maintenance of the normal supersaturated state of the various solutes is unknown.

One gram of RNA fed to a 70kg body weight adult by mouth increased urinary uric acid by 113mg per 24 hours above the pre-existing levels on a purine-free diet (*11*). In other studies 2g of SCP-nucleic acid given to normal subjects on their usual diets increased urine uric acid from 615 ($\pm$ 173)mg/24 hours to 904 ($\pm$264)mg per 24 hours and to 820 ($\pm$ 301)mg per 24 hours after one and six months respectively (*7*). Calloway (*1*) reported results which were similar when allowance is made for the fact that her subjects were not taking a purine-free diet.

Based on these observations, the working group recommended that the urine uric acid excretion should not exceed approximately 1000mg/24 hours. At this level of uric acid excretion, and under favorable circumstances of urine output (not less than 1500ml per 24 hours) and urine pH (not less than 5.6 in the absence of infection), uric acid urolithiasis should not constitute an unacceptable risk.

Some urinary tract infections increase the urine pH and might therefore increase uric acid solubility. Nonetheless, such infections should be treated vigorously. Every effort must be made to ensure higher rates of urine flow leading to more than 1500ml per 24 hours, as prophylaxis against all types of urolithiasis. The regular ingestion of an alkaline ash diet (predominantly vegetable) in certain areas of the world would appear to be a favorable factor that tends to increase urine pH and consequently uric acid solubility.

1.4 Recommendation

1.4.1 *Dietary limit of nucleic acid from SCP.* After reviewing the available published and unpublished evidence, the *ad hoc* Working Group concludes that a limit of 2g of nucleic acid from SCP added to the usual daily diet, with total nucleic acid from all sources not to exceed 4g per day, will represent a safe practical limit for most adult populations. However, the important consideration is the total daily nucleic acid intake resulting from any dietary modification. Based on the permissible 2g level of intake from SCP, Table II gives figures of intake for different age groups and the two sexes.

The reasons for considering that 4g of nucleic acid represent an acceptable level of risk for adults are given below and in section 1.4.2. This recommendation of a maximum 4g of nucleic acid is intended to cover

TABLE II. PERMISSIBLE LEVEL* OF INTAKE OF NUCLEIC ACID FROM SCP FOR DIFFERENT AGE GROUPS AND SEX.

Age group in years	Sex	Body weight in kg	Intake of nucleic acid† (purine Nx9) in grams
Adult	M	65	2.0
Adult	F	55	1.7
16 - 19	M	63	1.9
16 - 19	F	54	1.7
13 - 15	M	51	1.6
13 - 15	F	50	1.5
10 - 12	M	37	1.1
10 - 12	F	38	1.2
7 - 9	M, F	28	0.9
4 - 6	M, F	20	0.6
1 - 3	M, F	13	0.4

* *Assumption: a. 2g per day permissible for adult male of body weight 65kg; b. intake is proportional to body weight.*

†*SCP Product from Yeast*
(*Processing to reduce the RNA content will increase the amount of SCP that can be safely ingested, proportionately.*)

"nearly all" of the normal adult population, or in practical conceptual terms, the mean plus two standard deviations, i.e. all but 2.5 per cent of the normal population.

For example, when the nucleic acid content of the usual diet varies within the limits of 1 to 2g, an upper limit of 2g of additional nucleic acid per day would mean that relatively few individuals would be expected to approach this limit for practical reasons. The further chance of maximum nucleic acid SCP intake coinciding with maximum nucleic acid intake from other dietary sources is small except under experimental circumstances, since any large amounts of SCP-containing foods would normally be replacing other protein foods in the diet.

1.4.2 *Adjustment of RNA/Protein ratios to intended use.* The higher the proportion of total protein requirements proposed from SCP, the lower the ratio of nucleic acid to total protein will need to be. In theory an 8 per cent nucleic acid yeast would present no problems when used at 3 to 5 per cent levels as a food additive. A reduction of the RNA content of SCP to 3 per cent would permit its use as a significant protein supplement to the diets of older children and adults, and reduction of nucleic acid below 1 per cent would facilitate its use as a major protein source even in weaning foods and infant formulas, providing the material has been demonstrated to be free of other toxic factors.

The PAG *ad hoc* Working Group considers that few individuals in a population would actually be exposed to the 4g level, although it represents an acceptable upper limit.

In making these estimates the group recognized that at least 1 per cent of North American and European populations with diets as currently constituted will develop symptoms of gout if they survive beyond the age of 60. This is a reflection both of the high meat content of their diets and their relative obesity. It is noteworthy that nearly all persons developing gout under these circumstances are at least 10 per cent overweight and that the majority are more than 20 per cent above standard weight for height. Even so, gout in these populations is not a serious disease since it is readily managed by dietary restraint and drug therapy.

While renal stones are a somewhat more serious complication, they do not usually affect life expectancy and generally respond readily to medical management. For this 1 per cent there is no reason to believe that the risks of introducing purine-rich foods within the proposed limits are of sufficient consequence to require restricting their availability to the general population.

1.5 Additional information required

1.5.1 There is need for data on dietary purine intakes of various population groups by age and sex. The data should be expressed as intake per day and per kg body weight. Inclusion of information on protein intake will be useful. Useful data may be derived from recent diet survey records from various countries available from FAO.

1.5.2 Additional surveys may be required in specific population groups to obtain information on purine content of typical diets. Such surveys should include

data on prevalence of gout, urinary uric acid calculi and urinary tract infections in the population.

1.5.3 Data on serum uric acid and urinary uric acid from groups of populations of different age groups (adult males and females, adolescent males and females, primary school and preschool age groups) are lacking. A collaborative study, if undertaken in different parts of the world, would help to obtain comparable data.

The following plan is suggested for such a collaborative study:

- The study should be carried out in the field as well as in the metabolic ward.
- Male and female subjects of different age and body weights should be used. For adult subjects, body weight changes should be negligible for several weeks before study.
- The ethnic group, environmental temperature, physical activity of subjects, habits such as alcohol consumption, use of drugs, etc. should be noted.
- Food consumption data on a selected group in each center should be obtained.
- The level of nucleic acid fed should be 0.3g/kg/day for eight days at a time. The source and composition of nucleic acid should be the same for all centers throughout the study.
- Twenty-four-hour urine collections should be made wherever possible. Failing this, a timed three-hour specimen should be used.
- The following precautions should be taken during the study:

a) determination of urinary creatinine along with urinary uric acid, which would serve as a check on 24-hour urine collection and would help to provide the uric acid: creatinine ratio in samples collected over shorter periods; b) a routine clinical laboratory examination of urine, which would help to exclude possible renal toxic effects; c) adequate preservation of urine using toluene and standardized methods of analysis for uric acid.

Uric acid determinations in plasma and in urine are based on enzymatic analysis exclusively. Until recently, such analyses have utilized changes in the ultraviolet spectrum, requiring use of expensive U-V spectrophotometers. However, methods are now available that measure either the oxygen uptake (polarimetrically) or the hydrogen peroxide liberated (colorimetrically by coupling into another reaction). The results obtained using these new methods agree well with those given by the established techniques. They are also speedier and the apparatus needed is not so expensive. The colorimetric method can be used with almost any conventional colorimeter.

1.5.4 There is need for studies to confirm the effects of different intakes of RNA and DNA feeding in humans and on plasma and urine uric acid levels.

2. NEED FOR CLINICAL EVALUATION OF NEW PROTEIN SOURCES IN HUMAN SUBJECTS PRIOR TO REGULATORY APPROVAL FOR FOOD USE

The PAG has provided guidelines for extensive testing of new protein sources in experimental animals before cautious testing in human subjects. At present, the requirements of national regulatory agencies for approval of new food additives include extensive animal testing but not clinical testing. While no new material should be fed to human subjects prior to appropriate animal testing, there is good evidence from experience to date with various proposed new protein sources to indicate that clinical evaluation should be a required step in the approval procedure.

The group reviewed reports that three different SCP materials grown on two different substrates caused gastrointestinal symptoms in a small proportion of subjects, which had not been suggested by any of the extensive prior animal testing. The group suggests that any SCP product for human consumption should pass through clinical as well as animal testing before being considered for human use. It also suggests that the reference to tolerance testing of new protein foods in PAG Guideline (No. 7) for *Human testing of supplementary food mixtures* be revised to reflect the recent experience with observation of gastrointestinal allergy in some individuals consuming SCP material, not observed in either the majority of individuals or in

experimental animals including nonhuman primates. These observations suggest the need to include at least fifty individuals in each test group, the use of a placebo group and a double-blind procedure, and a minimum test period of 30 to 60 days. The level of feeding should be consistent with the intended use. Conclusions regarding the effects of feeding higher levels of the test substance should be not be extrapolated from tolerance trials at lower levels. It is further suggested that the list of products requiring full testing procedures described on page 2 of PAG Guideline No. 7 be revised so that products requiring full testing procedures, both preclinical (Guideline No. 6) and clinical (Guideline No. 7 are:

1. New processed or nonprocessed protein-containing foods which have not previously been considered in WHO/FAO/UNICEF testing programs.

2. Products previously considered as suitable but which have been subjected to various processing conditions that may raise questions regarding their nutritional or toxicological properties.

3. Products previously considered as suitable that are proposed for feeding at levels substantially higher than in the past.

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APPENDIX

1. Hyperuricemia and hyperuric aciduria—conditioning factors

Normal levels of serum uric acid have been most closely defined and their significance analyzed for people in some areas of the U.S. (*3*), (*9*), (*11*). However, more limited population surveys from Thailand (*4*) and from a rural community in South Africa (*1*) are noteworthy because they do not suggest a higher incidence of hyperuricemia in these populations. Conversely, the high incidence of hyperuricemia among Polynesians is well known (*18*). The possibility that other populations with a genetic predisposition to gout, particularly when a high purine intake is superadded, requires further study. For example, hyperuricemia is associated with the presence of an electrophoretically demonstrable variant of glutathione reductase that is common among some black American populations (*7*).

1.1 *Genetic factors and diet.* Several human groups appear to have hyperuricemia (in absolute terms of mean serum urate values exceeding the solubility of urate in serum) that cannot be attributed to dietary or other known environmental factors. This is the case among the Polynesians, including the Maori of New Zealand and Australia, full blooded Hawaiians, and the natives of Roratonga and Pukapuka. The adult male Maoris of New Zealand have an incidence of clinical gout of greater than 10 per cent (*12*). Many of the Polynesian peoples eat Western diets and are exposed to Western drinking habits,and thus significant numbers of them display the typical health problems of contemporary Western civilization: obesity, hypertension and alcoholism (*13*).

However, the Pukapukans are not westernized, are not obese or hypertensive, and consume no alcohol, yet are equivalently hyperuricemic (40 per cent of males have serum urate values greater than 7.0 mg per 100ml). Filipinos have a very low incidence of gout in the Philippines, but when they emigrate to Hawaii or to the Pacific Northwest region of the U.S. they exhibit an

increased incidence of hyperuricemia and gout, which have been attributed to dietary factors.

During World Wars I and II, acute gout virtually disappeared in Denmark and in Germany, only to re-emerge in the post-war era when dietary protein again became plentiful (*2, 19*). In Japan, gout was formerly a very rare disease. Since World War II the intake of protein per person has doubled, and gout is now a common disease of the obese middle-aged Japanese male. Gout is rare among black Africans but common among American blacks (*14*). It is likely that all populations are susceptible to gout when dietary protein, calories, purines and perhaps alcohol are abundant and ingested in sufficient quantity to produce hyperuricemia. In addition certain groups possess such strong genetic determinants for hyperuricemia that they carry an elevated serum urate value in the absence of environmental factors (e.g. the Polynesians) or such strong genetic predispositions to hyperuricemia that they respond briskly to dietary factors favoring hyperuricemia (e.g. the Filipinos).

Genetic factors present in recipient populations will have to be ascertained in each target group selected for SCP supplementation, and responses of serum urate values to the chosen level of supplementation determined in order to assess the potential for late development of gout.

1.2 *Sex.* The mean serum urate concentration is 3.4 to 3.7mg per 100ml in prepubertal children and is the same in both sexes. Levels rise at puberty, more so in the male, and thereafter mean levels are about 4.2mg $\pm$ 0.8 per 100ml in the female, 5.1 mg $\pm$1.1 per 100ml in the male. At the menopause, mean levels rise further in the female and thereafter approximate those found in the male.

In the person at genetic risk for the common forms of primary gout, serum urate levels are initially normal but rise excessively at puberty. In the male they frequently exceed the solubility limit of urate in plasma, which is about 7.0 mg per 100 ml, whereas in the female they rarely rise beyond this level until the menopause. Primary gout is predominantly a disease of the male (96 per cent), and the usual age of onset is about 45 years. Thus, 30 years of hyperuricemia usually precede the first attack of gout, but many gouty subjects report having had earlier uric acid stones, sometimes as early as 20 years before the first attack of articular gout. Primary gout is rare in females, and if present, generally occurs after the menopause.

Even gout occurring secondary to disorders of increased bone marrow activity, e.g., polycythemia vera and consequent increased uric acid production, is chiefly a disease of the male (83 per cent). Male predominance is also found in gout secondary to use of thiazide diuretics (70 per cent). One of the factors protecting the female against hyperuricemia is a higher renal clearance of uric acid perhaps due to estrogens (*17*). Transvestite males given estrogens showed an increase in uric acid clearance, with lowering of serum urate concentration values.

Given this background it is likely that the risk of gout would be greater in the male given nucleic acid supplementation through SCP products than in the female. At the level of 2g of nucleic acid supplementation per day continued throughout a lifetime and assuming an initial serum urate value of 5.3 $\pm$ 0.8 mg per 100ml (*15*), the resulting value of 6.7 $\pm$ 1.3 mg per 100 ml (*16*) would place 17 per cent of recipients at a 25 per cent risk of gout and 2.5 per cent of recipients at a 90 per cent risk of gout, by the age of 58 years. These risk factors, which are based upon data of Hall *et al.* (*6*) from the Framingham, U.S. study, are probably conservative for populations of males who may become obese or alcoholic in later adult life. They probably overstate problems for populations whose diets are more restricted in calories and protein.

1.3 *Obesity.* In population studies gout is statistically associated with obesity, hypertension, arteriosclerosis, hypertriglyceridemia and alcoholism. However, careful epidemiological studies indicate that the hypertension, arteriosclerosis and hypertriglyceridemia of gout are associates of obesity and not of hyperuricemia *per se*. When non-hyperuricemic and hyperuricemic populations are matched as to body weight, there is no excess of hypertension (*10*) or of hypertriglyceridemia among the latter (*5*). Excess coronary artery events are found only among the overtly gouty, not among the asymptomatic hyperuricemics (*6*).

There is little reason to fear that elevation of the serum urate level secondary to dietary supplementation with SCP will lead to excess hypertension, hypertriglyceridemia and arteriosclerosis in the absence of

obesity. Obesity is not a likely precondition or consequence in populations consuming diets deficient or normal in proteins and calories. However, the obesity factor will play a larger role in technologically advanced countries in which SCP may be used to replace other sources of protein. The limits of a total ingestion of not more than 4g of nucleic acids daily should be adhered to; plasma urate levels should be kept below 8.0mg per 100ml; and urinary uric acid excretion value should be kept below 1000mg per day.

1.4 *Alcoholism.* Many population studies have shown a correlation of hyperuricemia with alcohol ingestion. Chronic alcohol use may lead to hyperuricemia by several mechanisms. There is evidence that 100g of ethanol per day may lead to increased uric acid production, and elevated serum and urinary uric acid levels (*8*). Ethanolism may lead to hypertriglyceridemia, with the possibility of increased urate binding by serum lipoprotein. Acute inebriation leads to hyperlacticacidemia with hyperuricemia in part due to interference with uric acid secretion by the renal tubules. These effects of ethanol would be superimposed upon the existing serum urate level resulting from endogenous purine nucleotide catabolism plus the dietary component including that from supplements if any, but the resulting elevations of serum urate concentration values would not likely be greater than found in many of the world's populations with adequate nutrition and alcohol habituation.

1.5 *Drug ingestion.* In westernized populations, several drugs lead to development of hyperuricemia. Chief among these are the thiazide diuretics. In the Framingham study, one-half the new cases of gout occurred in patients taking thiazide diuretics. Most of these were past middle age (mean age 58 years), hypertensive and with cardiovascular renal disease. Other drugs capable of causing hyperuricemia sometimes complicated by acute gout include pyrazinamide, ethambutol, and salicylates in low doses. These drugs are unlikely to be in widespread use in countries with need for dietary supplementation with SCP, but the effects of such drugs should be kept in mind.

1.6 *Dehydration.* Since it is a rich man's disease, the risk of development of gout as a consequence of SCP supplementation of the diet of poor people seems small. Should it occur, however, the acute disorder can be readily treated, and the chronic hyperuricemia can be treated with allopurinol or the supplementation can be discontinued. The risk of renal uric acid lithiasis is probably greater and is increased during periods of low urine volume and low urinary pH. The limits of solubility of uric acid in urine are 150mg per litre at pH 5.0 and 2000mg per litre at pH 7.0. Supersaturation of uric acid in urine is somewhat greater than these levels at all pH values below 7.2 because of the presence of urea, mucoproteins, and other crystallization-inhibiting substances.

Urine is normally supersaturated with uric acid in most subjects most of the time. The degree of supersaturation will be increased as a result of SCP supplementation at the level of 2g of nucleic acid unless urine volume is increased in proportion to the increase of uric acid excretion.

The risk of urinary uric acid crystal or stone formation will be increased by any factor that reduces urine volume without a commensurate reduction in uric acid excretion. These include dehydration due to reduced fluid intake, increased sweat loss from severe exercise or work in a hot arid climate, diarrhea, vomiting. Severe dehydration also leads to a more highly acid urine, which is intensified by even short periods of starvation and ketosis. Increases of urine concentration and urine acidity will increase the risk of stone formation, particularly if dietary supplements high in purines are continued under these conditions.

1.7 *Urinary tract infection.* Infection of the urinary tract is unlikely to affect the risk of uric acid stone formation appreciably except as it may lead to fever, reduced fluid intake and other events tending to diminish urine volume. Infections with urea-splitting organisms, such as *Proteus vulgaris*, tend to alkalinize the urine by producing excess ammonia and might reduce the tendency toward uric acid crystallization.

2. Uric acid metabolism in children and in pregnancy and lactation

2.1 *Children.* Serum urate concentrations average 7mg per 100ml in both mother and baby at the time of birth. The so-called uric acid infarcts of the newborn kidney are not true infarcts, rather they represent uric acid crystals in the collecting ducts of the papillae. These may be related to the temporary hyperuricemia of the

newborn but are not pathological and promptly disappear without producing renal damage. Postnatal serum urate levels quickly decline to about 3.5mg per 100ml by the fourth day of life. They are then constant at this level in both sexes until puberty. The low values seen in children have been attributed to a relatively high renal clearance of uric acid compared with the adult. In the adult about two-thirds of the urate turnover is disposed of by urinary excretion and one-third by entry into the gastrointestinal tract, where uric acid is digested to ammonia and CO_2 by intestinal organisms. It is not known whether this partition also applies to children with their lower serum urate levels and higher urinary uric acid clearances, but it is unlikely that the fraction of the turnover entering the gastrointestinal tract is larger than in the adult.

Fluid requirements of the child are considerably greater than in the adult, gradually declining from 110ml per kg per day in the nursing newborn to 20 or 25ml per kg in the adult. The excretion of endogenously produced uric acid also declines with age and reaches 5 to 7 mg per kg in the adult. Creatinine clearance, which is about 1mg per kg per minute in the newborn, gradually rises to about 2mg per kg per minute by age ten.

The interplay of these factors of higher fluid requirements (and resulting higher rates of urine flow) and greater renal uric acid clearance, despite the low initial cretinine clearance compared with the adult, offer the prepubertal child a relative protection against the development of high concentrations of uric acid in blood and urine in response to dietary nucleic acid ingestion.

It would appear that the recommended adult level of SCP supplementation (approx. 0.03g per kg body weight) could also be offered the child, if necessary, on a weight basis. Appropriate attention to fluid intake must accompany this regimen, because of the increases in urinary uric acid excretion values.

2.2 *Pregnancy and lactation.* Women before the age of menopause have lower serum uric acid levels than men and rarely develop gout. During the first two trimesters of pregnancy, serum urate levels are slightly lower, and urinary uric acid clearances slightly higher, than in the non-pregnant state. In the final trimester these values are the same as in the non-pregnant. These physiological changes should represent no contraindication to SCP supplementation during pregnancy. During lactation the uric acid content of breast milk is negligible and any small increase associated with nucleic acid ingestion would be of no physiological or pathological significance.

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Nutritional nuances of the term *preschool child* and the need for precise definition

P.S. Venkatachalam

The convenient adjective *preschool* is often understood to mean the period of life from birth or weaning until entry into primary school. The terms *preschool children* and *preschool age group*, often used in nutrition circles, leave room for different interpretations. The use of the adjective in articles and discussions on *a.* prevalence of childhood malnutrition, *b.* interpretation of mortality records to ascertain the role of malnutrition as the underlying or associated cause of death and *c.* nutrition plans and programs for children, often refer to age groups zero to four years, zero to five years, one to four years and one to five years and also, rarely, to children zero to six and zero to seven years.* Preschool is also used with different meanings by the different professionals engaged in nutrition work—nutritionists, health workers, home economists, teachers, etc.

To professional health workers, the term *infancy* refers to the period from birth to twelve months. The age of weaning and the age of entry into primary school vary in different countries and cultures. Moreover, the term preschool presupposes that school attendance is firmly integrated into a society's way of life and that adequate educational facilities are available. Thus, the opportunity for schooling is not always available for many children in many parts of the world so that preschool would have no relevance in those places. Nevertheless, the adjective preschool in the traditional context will continue to be used as a convenient expression, and then it should be used only to include children from birth to 60 months.

** Strictly speaking, upper age limits expressed in years refer to the point in time up to but not including the child's next birthday after the limit. Thus zero to four years covers the period from birth to the day before the fifth birthday. To avoid this confusion, ages given in this paper are in months, so that for example, six to 12 months covers the period from the six month birthday to the day before the first birthday.*

A gradation in nutritional vulnerability

Young infants (birth until six months). The food of choice for the young infant is mother's milk, and breast-feeding should be promoted among all mothers. Traditional feeding of young infants in all parts of the world has always depended on the availability of a sufficient supply of human milk. A decline in breast-feeding and shortening of the duration of lactation has been reported in many less technically developed areas of the world with increasingly serious nutritional consequences to the young infant below six months. The dimensions of this change vary considerably from country to country. Further, study is required on the complex, interrelated factors that predispose to early weaning or to failure in breast-feeding and the extent of their prevalence.

Alternative feeding is a critical nutritional risk situation regardless of the nature of the substitute for mother's milk. Indeed, a predictable change in the pattern of malnutrition already has taken place in certain urban areas in developing countries. If alternative feeding becomes necessary in specific cases, the four basic essentials required are sufficient money, proper use of the substitute food, adequate food hygiene and the appropriate maternal education.

Older infants (six to 12 months) and younger preschool children (12 to 36 months). This prolonged stage, which can be designated the weaning period, is an important transitional phase of considerable nutritional risk. The baby, not unlike the young infant, is totally dependent for nutritional support. Mother's milk should be given as long as possible, but the declining supply must be reckoned with. Although beneficial, mother's milk should not be the exclusive source of nourishment after six months of age. Other foods should play a successively greater primary role, and they must be introduced in the diet gradually. Their selection should

be in stages, based on the physical consistency of the prepared food. (For examples, see *PAG Manual on Feeding Infants and Young Children* by M. Cameron and Y. Hofvander.) Rapid growth and development at this stage of life constitute a great nutritional demand. This also is a period of great susceptibility to various common childhood infections and infestations which can lead to serious effects on nutritional status.

The complex socioeconomic and cultural factors and the frequent episodes of infections make this perhaps the worst period of risk for various types and severity of malnutrition and their consequences not only in urban but also in rural areas. The consequences of malnutrition for those under age 36 months are not only retardation of physical growth and development but also similar effects on learning abilities and behavior.

Older preschool children (36 to 60 months). Children past their third birthday with satisfactory health and nutritional status may be expected to be less dependent and more able to move around by themselves. They are able to chew, swallow and digest sufficient quantities of their families' mixed diet if served in small portions at a time and can consume a variety of other foods, whenever available. The chances of developing acute severe malnutrition are comparatively less at this stage particularly if the health and nutritional history in the preceding years had been satisfactory.

Prevalence of malnutrition

The major types of nutritional deficiency diseases observed in children of preschool age group (zero to 60 months) are protein-energy malnutrition (PEM), hypovitaminosis A and anemia. Other nutritional disorders like B-complex vitamin deficiency, rickets, etc. are either of local or regional importance. Figure 1 provides very rough graphic representations of the prevalence of the three major types of malnutrition in this age group, and another of the mortality pattern year by year. It is obvious that in the preschool age group, the period six months to 36 months is the most vulnerable for nutritional stress. For the infant under six months, the extent of vulnerability depends on the maternal nutritional status during pregnancy and on whether the infant is successfully breast-fed or not. Although older preschool children (36 to 60 months) do suffer from malnutrition, their vulnerability is far less when compared to the age period six to 36 months.

Needs of children of preschool age group

The special needs of children and the problems that arise when they are unfulfilled are closely related. Adequate food and nutrition, health care and prevention of common diseases, proper shelter, and adequate facilities for emotional stimulation in the family and in the community in the form of play and recreation are some of the special needs. These special needs and their manner of provision are not the same throughout the early years. The priority of the needs depend on the age sub-groups within the entire preschool age group.

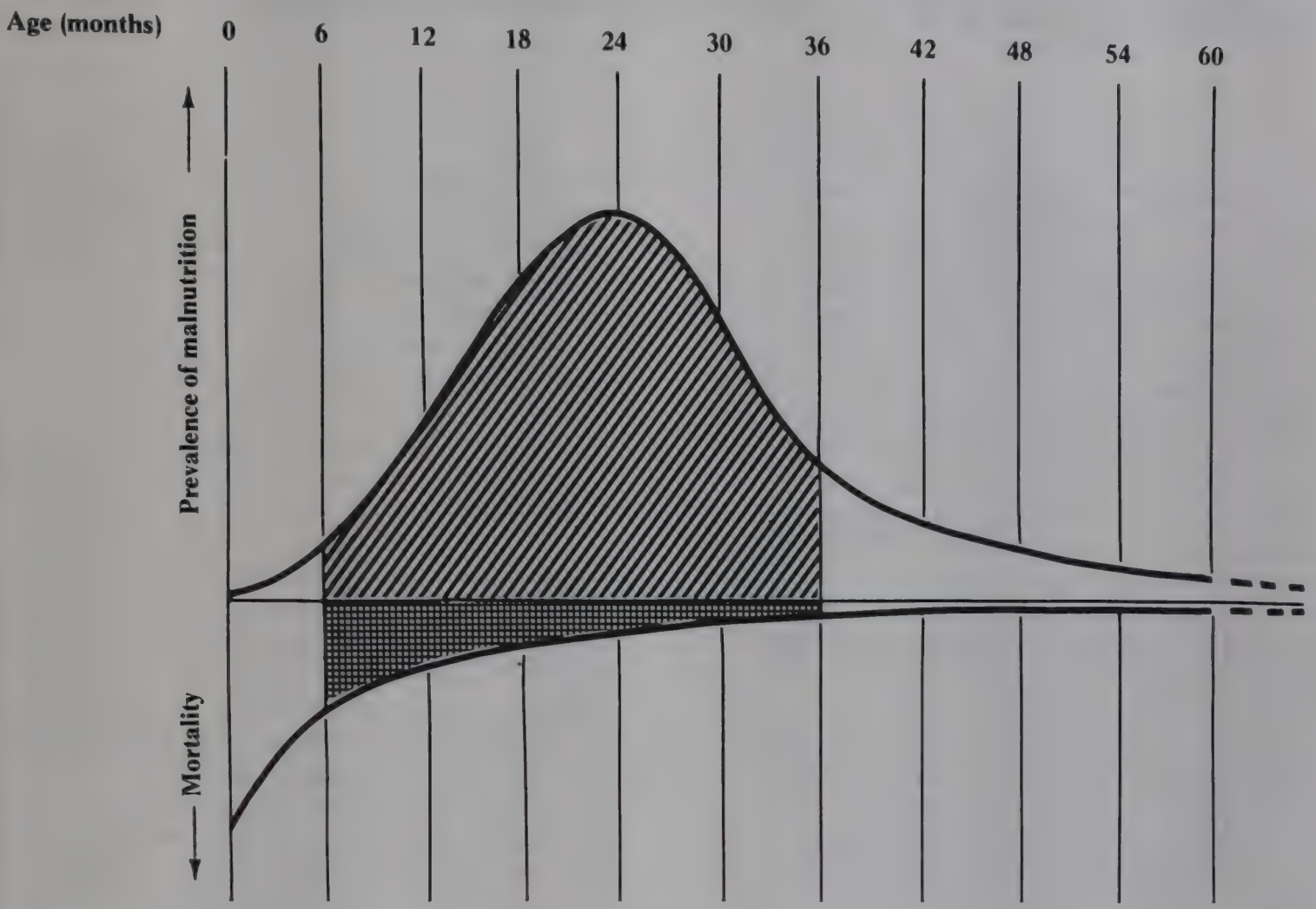
For the younger infant, the problems of health and nutrition should receive absolute priority. Supervision of their health, immunizations, protection and promotion of breast-feeding, the nutrition and health education of the mother and legislation for improving conditions of working women are some of the components of action. For older infants and younger preschool children, health protection and nutritional improvement are once again priority needs. These have to be provided through integrated mother and child health programs. A comprehensive service should include programs on spacing births and should also provide curative services working in close coordination with preventive and educational efforts. An important objective of programs for the above two age sub-groups should be to treat the mother and child as a single unit whenever problems are considered and solutions sought.

For the age sub-group 36 to 60 months (older preschool children), social and educational programs take equal priority with health and nutritional support. When health and nutritional protection of children under 36 months has been satisfactorily attained, less effort and investment are required beyond this age period.

Redefinition of priorities

In view of the growing interest in large-scale programs for improving nutritional status and health of children of the preschool age group and for the reasons discussed above, it is suggested that a) the term *preschool age group* be used only to refer to the total period from birth to 60 months, and b) this age period be subdivided as follows to emphasize the nutritional priorities within the subdivisions and stated clearly in all publications, plans, projects, etc.:

FIGURE I. CURVES OF MALNUTRITION AND MORTALITY



These curves do not refer to data from any specific country, region or situation. They are presented to illustrate the point made in the text regarding the magnitude of the situation relative to age. The types of malnutrition would include severe PEM, vitamin A deficiency and anemia. It should also be noted that high mortality in the early weeks after birth is due to a complex group of prenatal, natal and postnatal factors.

Expression/Terminology	Age range
Young infants	0 to 6 months
Older infants	6 to 12 months
Younger preschool children	12 to 36 months
Older preschool children	36 to 60 months

The foregoing suggestions retain the useful and well understood term *preschool age group* and provides familiar terms for the different age sub-groups with different nutritional problems and priorities. It should be emphasized, however, that the use of these expressions is for convenience only when presenting ideas, understanding approaches or providing for needs through appropriate programs; it is not meant for application blindly as target dates demarcating transformation from one set of conditions to another.

Acknowledgements

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Energy and protein requirements — recommendations by a joint FAO/WHO informal gathering of experts

Reliable standards relating to physiological requirements are needed in order to estimate nutritional needs of populations. Probably the most important standards in terms of national and international planning are those for energy and protein because the need for these nutrients determines to a major extent the amount, composition and cost of food supplies. These standards, reflecting physiological requirements, are properly used to set nutritional targets and to assess intakes of populations. Comparison of an array of intake and requirements values for households in communities or for groups of individuals of a given age-sex category can indicate nutritional risk — that is, the probability of deficiency in the populations examined, even though deficient individuals or households cannot be identified from this information alone. Requirements figures are often used to estimate the food energy and protein needs of communities and nations. This is commonly done to compare availability of food supplies with population needs in deriving food balance sheets. All that these balances can show is whether or not a nation has enough food potentially to meet its needs, not who or how many may be malnourished, as this depends upon how equitably the food is distributed.

In 1971 FAO and WHO jointly convened an *ad hoc* Expert Committee to reconsider the evidence relating to human requirements for energy and protein. The report of this committee, published in 1973 (*1*), presents average requirements for energy and safe levels of protein intake.

The safe levels of protein intake are given in terms of the reference proteins, egg and milk, and are based on amounts of these proteins required, under laboratory conditions, to support adequate protein retention in growing children and to maintain adults in protein equilibrium. The safe levels are set 30 per cent higher than the average requirements and are expected to meet the needs of nearly all healthy individuals in a normally distributed population. These safe levels are significantly lower than previously recommended allowances derived in a different manner (*2, 3*). A revised amino acid requirements pattern was developed by the committee for chemical scoring of protein quality, and this score or a biologically determined net utilization value is to be used to adjust the safe levels of protein intake according to the actual quality of dietary protein.

Energy requirements as given in the Report* (*1*) are for average populations, meaning that half of the individuals will need more and half less energy than is specified. Four grades of physical activity of adults are described, but all children are assumed to be moderately active. Adjustment of requirements according to climate had been suggested by a previous committee (*4*), but this procedure was abandoned as there was deemed to be no basis for proper quantification of a climatic effect on needs. On the basis of a factorial analysis of energy requirements a maintenance level of energy intake was identified, i.e. a level that would allow for essential body processes and the minimum amount of activity needed to exist. To maintain body energy content constant under these conditions was estimated to require 50 per cent more energy than the basal metabolic rate (BMR: the energy expenditure of a person who is relaxed and comfortable, in the morning soon after awakening and 14 hours after his last meal).

As there was no evidence to indicate whether proetin and energy requirements are correlated, the committee made no recommendations concerning safe or desirable protein-energy ratios in diets.

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* *"The Report" referred to in this paper is always Reference 1.*

Requirements for protein and energy were related to units of body weight wherever possible, to accommodate for populations of various sizes. However, the committee recommended that, where size was limited due to nutritional inadequacy, needs of preadolescent children should be computed according to the size of well-nourished children of the same age. (Tables of heights and weights of a North American population were given as examples for use in such calculations, there being no comprehensive data from appropriate segments of other populations.) The requirements figures thus make allowance for catch-up growth of children, and maintenance of actual body weight of adults.

In the four years since the committee met, FAO and WHO have accumulated experience in the practical application of the standards promulgated. A number of problems have been encountered. Questions have been raised, for example, concerning the proper applicability of such standards for food planning and for assessment of nutritional status of population groups; the validity of protein allowances to populations having high prevalences of infectious diseases (5); the classification of activity levels of populations in different regions; and the reference body weights. FAO and WHO, with the participation of PAG, assembled a group of consultants to discuss these issues with agency staff in Rome, 14 to 18 April 1975. Their report follows.

I. APPLICATION OF ENERGY REQUIREMENTS

Calculations of both energy and protein requirements are utilized for two main purposes: firstly, to provide a standard against which an existing dietary intake of a population, as depicted by survey material, can be assessed; and secondly, where an unsatisfactory state is present, to provide targets for improvement. The way in which energy requirement scales are applied should be determined by the end purpose — either as an assessment or as a target.

Analysis and interpretation of data on food energy intake affecting energy requirement should take into account all available information on the variables that affect requirements, such as age, height, body weights and existing activity patterns. If such information is obtained, an assessment of the *status quo* or baseline situation may be given.

For purposes of planning for an improvement of energy supply within a set period of time, requirement scales can be adjusted to incorporate targets in the mid-term as well as long-term.

In this context particular emphasis is given to increased growth rates for children. Adjustments may also be made for providing for increased levels of physical activity insofar as these may be inhibited, both in children and in adults, because of a shortage of food supply, or because of proposals for changes in the levels or patterns of types of employment in the working population.

Adjustment for body weight

Adults. Problems have arisen in the calculation of energy requirements for populations because of difficulties in interpreting either actual weights of adults or desirable weights for children. In the case of adults, although the Report states that "requirements for both energy and protein should be related to the expected weight for height of the adult population" and although in various parts of the Report the committee warns about the possibility that excess adipose tissue may account for a significant part of relatively high body weights, a problem still occurs when calculations are made for the whole adult population of a country. This is because the actual weights of adults in many countries of the world show increases with aging. Therefore, when the age groupings are taken as they appear in the Report (i.e., 20 to 39, 40 to 49, 50 to 59, and so on), it may frequently happen that the mean weight of the group 20 to 39 is heavier than that of men and women age 25, and that the weights of the older groups are heavier still.

It is uncommon for adults over the age of 25 to increase their lean body mass other than a small increment associated with an increase in their mass of adipose tissue, which is seldom desirable. Therefore, for target energy needs and for assessment of adequacy of energy supply of large population groups it is suggested that the body weight for all ages of adults should be taken as that

for the 25-year olds, when this is known. The precise standard for the 25-year body weight is not necessarily the actual weight but an appropriate weight for height. In the future it will be possible to calculate this on the basis of anthropometric information from 15 countries, at present being assembled by WHO, together with the contributions from FAO.

There is a physiological reduction in lean body mass with aging but the extent of this is not sufficiently known at present and it varies due to other factors, such as the amount and type of habitual physical activity, so no deduction should be made in the 25-year weight for older groups.

In the assessment of the existing situation for adults, comparisons are often made between actual energy intakes and the requirements as calculated using the observed body weights of the individuals studied. This may introduce some bias for those individuals who are lighter or heavier in weight relative to their height. An alternative and perhaps better method would be to derive a more desirable weight from the observed height for each sex for any given adult age. This can be done by deriving an equation giving median weights for the required range of heights. For example, the heights and weights of adult males of age, say, 20 to 39 years, could be measured and for various heights in this group the median weights could be taken. An equation can then be derived relating height to the median weight. Whenever possible, these standards should be compiled on the population to be studied.

Children. For children the 1971 committee recommended that 50th centile size of a well-nourished population be used with "the intention . . . to provide for catch-up growth." These weights of the reference children as given in the Report may seem too high, both as a target and for assessment purposes, when applied to a population in which adult body weights are low. By itself this discrepancy may merely indicate a chronic state of undernutrition of the population. The divergence between the existing state and the target may appear very different depending on the standards used for the desirable weights of children of different ages.

The recommendations in the Report are perhaps not sufficiently logical and clear. For example, it is a biological fact that growth may occur, especially in situations where physical development is slow, until the age of 20 years, or even longer. Since it is the committee's intention to encourage catch-up growth, it would be more sensible to calculate the target energy requirements in children on a desirable rather than actual weight basis through the ages of 16 to 19 years, rather than using age 13 years as the cut-off point as the Report suggests.

This makes it more important, however, to have acceptable standards of desirable body weight for the various ages of children. We would have considerable reservations about the justification of a general application of the weights for age as given in the Report. Indeed the Report stresses the inherent problems. It states clearly that in relation to the data given in Tables 29 and 30 ("Percentiles for weight and height of males and females aged 0 to 18 years," which are those of the Harvard and Iowa growth studies) "the committee does not intend that they should be considered a standard of normal growth and development." Nevertheless, the fact that these growth studies are the ones used in the tables of the Report has resulted in their being widely applied for calculation purposes.

Where targets of desirable weights are required, it is strongly suggested that whenever possible the standards should be assembled from statistically acceptable anthropometric data on children from healthy population groups within a country whose growth has not been limited by environmental, socioeconomic or nutritional constraints. The 50th centile for the various ages in these children should be accepted as the desirable norm for that country.

If such data are not available for a given country or population, any data of a comparable nature on other genetically similar populations should be used as the standard for projected weights and heights. In the absence of any relevant anthropometric data, it may be that the 50th centile of the Harvard-Iowa standards is the only useful index, but this may not necessarily be ideal.

For the assessment of the extent to which energy needs are being met in an existing situation, the simplest comparison is between actual energy

intakes and the requirements as calculated from the tables in the Report, using the actual weights of the children. However, a limitation of this assessment is that it does not take into account children who are too thin or too fat. In these circumstances, it is preferable to calculate a standard weight on the basis of the *actual* height using Tables 29 and 30 of the Report. For *assessment,* the energy allowance per kg standard body weight should be based on the age group to which the observed height corresponds, through age 19 years.

Thus, in summary, for target purposes, desirable weight for age of children should be derived, preferably from suitable local anthropometric data, less acceptably from suitable data on comparable genetic groups and, possibly least acceptably, from the Harvard-Iowa standards.

For assessment purposes, standard weights for actual heights should be derived. The Report tables may be used in this connection.

Implementation of the above recommendations will lead to some different results compared to previous calculations. The requirements of most adult groups in developed countries and some groups in developing countries will be slightly reduced, because of taking the 25-year weight to apply to all adult groups. The target energy requirements for children will be increased for many populations, although the extent of this will depend on whether or not locally derived desirable body weights are used and if these differ significantly from the Harvard-Iowa values.

Physical activity levels

Adults. Where information on physical activity of a population can be obtained, this is obviously highly desirable. Where such information does not exist, some division of populations into rural and urban may be possible. For all countries, rural populations may be assumed to be at least moderately active.

Urban populations may vary considerably. In the developed countries, perhaps half the urban population will be classed in "light activity," and while in developing countries the proportion may be less, until more useful information can be obtained, an assumption that 50 per cent are in "light activity" and 50 per cent in "moderate activity" may also be a reasonable division.

These suggestions apply to male populations. In developed countries, urban female populations should probably be categorized as in "light activity," although specific information in certain developed countries or populations may require a different classification. In developing countries, it can be assumed that "moderate activity" probably represents the average for the female population.

A category of "light activity" for children and adolescents. The classification of adult activity patterns has proved to be a useful concept. The 1973 Report offered no comparable categorization for children or adolescents. A practical approach would be to attempt to define a level of energy intake which would be sufficient to support normal body functions and growth in children, and provide sufficient extra energy for voluntary activity equivalent to that attributed to the "light activity" category of adults.

Data for this purpose are very limited. However four studies are relevant. Studies (*6-8*) in the United Kingdom in adolescents age 14 to 15 years yielded the following data:

	FAO/WHO energy requirements	Observed intake	% of requirement	*Ratio, Intake: BMR*
	Kilocalories per day			
Boys	2,950	2,610	88	1.7
Girls	2,500	2,020	80	1.4

A study (*9*) one- to three-year-old children in Uganda, in apparent good general health and growing well, although short in stature, described a mean energy intake of 70 kcal/kg, about 70 per cent of the requirement level suggested in the 1971 Report, and about 1.3 times the BMR plus an allowance for growth.

In the U.K. studies there is reason to believe that current activity levels are lower than may have held in the reference population considered by the FAO/WHO Committee. In the Uganda studies direct observation confirmed that activity was less than that of European children living in Uganda.

In the absence of more definitive information, it is suggested that for "light activity" categories in children and adolescents through age 19 years, the energy requirements specified in the 1973 Report be multiplied by 0.8. It is interesting to note that this figure is close to 1.5 times the BMR plus an allowance for growth as appropriate, using the BMR tables published in the Report. It is stressed that this is an interim guideline and should be the subject of additional research. It, like the energy requirement figures, would be expected to have a variability among individuals, but no guidance is offered about the magnitude of this variability.

It is emphasized strongly that although energy intake levels consistent with this category of light activity are found in well-nourished populations, there is no suggestion that such low levels of intake and expenditure should be recommended as desirable, particularly in young children. Below this level of intake, the population group or individual will have little opportunity to adjust to dietary energy restriction by reduction in voluntary physical activity.

Climate and climate-activity interactions

In the Report there was thought to be little quantifiable basis for suggesting an influence of climate on energy requirements, either by peoples living in cold climates higher or those in hot climates having lower energy needs than peoples of temperate zones. Therefore, no adjustment for climate was recommended in the Report. The result of this recommendation is that there has been a small increase in the energy requirements of populations in hot countries and a small reduction in those of cold countries, relative to calculations based on previous reports. Little new evidence has been published since 1971 which would allow any new conclusions on the effect of climate.

It is probable that the pattern of physical activity which occurs during the day is affected by climatic factors, but no new information on any effect on the average total daily physical activity is available. There does not, at present, seem to be any reason for suggesting an alteration to the approach given in the Report.

II. APPLICATION OF PROTEIN REQUIREMENTS

Amino acid pattern and scoring. FAO has noted that experience with the new amino acid reference pattern has shown that protein scores calculated as recommended by the 1971 Committee are consistently higher than were those based upon either the whole egg pattern proposed by the 1963 Committee (*3*) or the reference pattern suggested in the 1957 report (*2*). Such new evidence as is available indicates that the new pattern is satisfactory but it was recommended that this pattern remain under review.

In recognition of the fact that differences in digestibility affect the utilization of protein, an adjustment for digestibility is justifiable in calculating amino acid scores to be applied in deriving a safe level of dietary protein. Table 1. provides representative data on true digestibility of proteins from a variety of sources. Since the safe level of protein intake is based upon the ingestion of milk or egg protein, it is appropriate to express digestibility of other proteins relative to that of egg and milk, as shown in the table.

Southgate and Durnin (*10*) have reported that the apparent digestibility of a mixed diet fell from about 92 per cent to 85 per cent, as large amounts of fruits and vegetables contributing plant polysaccharides were added. Thus, the overall composition of the diet requires consideration.

Having reviewed the above data, it is suggested, as a guide, that amino acid scores of diets based on coarse, whole-grained cereals and vegetables may have a correction for digestibility in the range of 85 per cent and that diets based upon refined cereals may have applied a digestibility figure of about 90 per cent.

Thus, to derive an approximate net utilization figure, the adjustment would be:

$$\text{amino acid score} \times \frac{\text{digestibility}}{100}.$$

The estimation of dietary protein need would be:

$$\text{safe level of egg and milk protein} \times \frac{100}{\text{amino acid score}} \times \frac{100}{\text{digestibility}}.$$

Biological evaluation of protein quality

The 1971 Committee recognized that the amount of egg or milk protein (nitrogen X 6.25) required to meet average protein needs was approximately 30 per cent more than the obligatory nitrogen output: that is, the amount lost from the body by persons consuming a protein-free diet. The safe level of intake was expressed in terms of egg or milk protein and adjustment for dietary protein of lesser quality was to be made by a formula, using amino acid scores as noted above, or by NPU† values:

$$\frac{\text{NPU of egg or milk}}{\text{NPU of test food}} \times \text{safe level of intake of egg or milk}$$

Present evidence (*12 - 16*) indicates that the efficiency of protein utilization in man, as well as animals, becomes poorer when proteins are fed at or near requirements levels. It may be that conventional NPU values are not applicable under these conditions. Recommendations for further research are offered elsewhere in this paper.

III. INFLUENCE OF INFECTIONS

Among poor communities in many developing countries there is a high incidence of infections of various types. These infections depress appetite; often

†*NPU, net protein utilization, "refers to a value derived from feeding a diet in which protein was the single limiting nutritional factor and then measuring the percentage of ingested nitrogen that was retained for growth repletion or maintenance, i.e. the product of biological value and [true] digestibility"* (1).

TABLE I. SOME OBSERVED PROTEIN DIGESTIBILITIES

Protein source	True digestibility %*		Approximate digestibility relative to egg or milk
	Children†	Adults§	
Egg	92, 97‡	97	100
Milk	93, 91‡, 90‡	97	100
Maize	82	76	82
Rice, polished	85	84	90
Wheat, whole	—	79	83
Wheat, refined	93	89	96
Soybeans	—	78	82
Soy protein, isolated	92, 95‡, 88‡	—	97
Mixed vegetable diets:			
Corn + beans	78		82
Wheat + soy protein	83		87
Incaparina	77		81
Indian rice diet	77#		81
Mixed vegetable/ animal diets:			
Corn, beans, milk	84		90
Corn, soya, milk	94		100
Corn-soya blend	87		92
Indian rice diet + milk	87#		92
Fish flour, millet and peanut flour	83‡		87

* *True protein digestibility per cent* $= \frac{N \text{ in diet} - (\text{observed fecal } N - \text{endogenous fecal } N)}{N \text{ in diet}} \times 100$

† *Values, except as noted, from Viteri, Bressani and Arroyave* (11).

‡ *Values from DeMaeyer and Vanderborght* (12).

§ *Values, except as noted, from Atwater as quoted in FAO/WHO Report* (1).

\# *From Panemangalore et al.* (13).

result in withdrawal of solid food from the diet; cause increased loss of energy, protein and other nutrients; and interfere with absorption of various nutrients. Infectious diseases thus impair nutritional status. This is particularly a problem among young children, because of the high frequency of infections in this age group.

In view of this relationship, significant improvement in the nutritional status of individuals in these communities would be brought about through reductions in the incidence of infectious diseases. The efforts of food planners and nutritionists in many developing countries will continue to be frustrated if the current high prevalence of infections impairing the effective utilization of available food is not effectively prevented and controlled.

Individuals suffering from the aftereffects of infection will need additional food energy, protein and other nutrients for adequate recovery. However, a blanket increase of recommended intakes of energy and protein for the community is not the proper strategy to deal with this problem.

The right strategy would be to improve public health measures in the community, so that infections are prevented and controlled, and available food is thus better utilized by the community. It is also essential to ensure that normal nutrient requirements are met.

IV. PROTEIN-ENERGY RATIO

In examining the general qualify of a diet, it is useful to express nutrients per unit of food energy.‡ Such a ratio may serve as a rough guide in the design of food mixtures, together with consideration of the total diet.

Proetin-energy ratios have been calculated in a variety of ways, without firm agreement as to either the correct way of calculating such ratios or the proper use of such ratios if calculated.

In the present connotation, the "safe" protein-energy ratio would be one that would be expected to meet the protein needs of almost all individuals when their energy needs have been met. Ratios might be calculated as illustrated in Figure 1. The ratio of average protein requirements, point E, is already inappropriate, since at least half of the individuals will have an inadequate protein intake. The ratio of the highest protein need and lowest energy need, point C, would clearly satisfy all. However, the probability of individuals falling in this particular position is very low, even if there is no correlation whatsoever between protein requirements and energy requirements.

The question can be approached through probability statistics. In accord with the recommendation of the 1971 Committee, Beaton and Swiss (*18*) have published predictions of safe ratios based upon the energy and protein requirements estimates published in the Report and taking into account variability of requirements for protein and for energy and the estimated correlation between them. On condition that energy requirements as defined in the Report were met, they predicted that the needs of all but 2.5 per cent of individuals would be met by the following levels of egg and milk protein, expressed as *per cent of dietary energy:* for two- to seven-year-olds, 5.1; for six- to eight-year-olds, 4.9; for 12- to 14-year-olds, 5, and for adults, 5.4.

Calloway (*19*) has provided direct experimental evidence in adult subjects that 5 per cent of energy as egg protein was inadequate to maintain balance in her subjects; however, 7 per cent of energy as egg protein was adequate. Part of the discrepancy between prediction and experiment rests with the level of voluntary activity. The subjects in this study were found to require 40 kcal (167 kJ)/kg, whereas the Beaton and Swiss prediction had been based on an adult at the "moderate activity" level requiring a mean of 46 kcal/kg. People doing light work, hence ingesting less food, need a higher protein-energy ratio in the diet.

This may also happen with children reared in a setting where energy balance is maintained in spite of chronic low energy intake. Rutishauser and Whitehead (*9*) have noted that, in such a setting, children may exhibit low voluntary activity without evidence of a major effect upon growth. If energy intake were significantly lower, an effect upon growth would be expected. This is not a common situation, but there is reason to believe that it is not unique.

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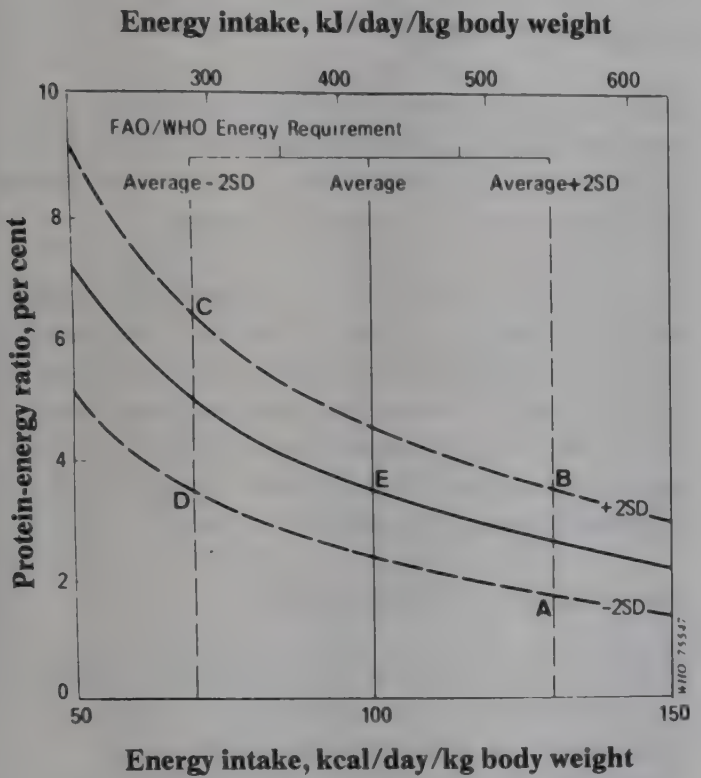
‡ *The protein-energy ratio in a given diet is calculated as follows: amount of dietary protein in grams, times the specific energy value per gram of that protein, divided by the energy content of the total diet. Commonly an energy value of 4 kcal per gram is used for protein and the final ratio is expressed as per cent.*

FIGURE 1. *The solid vertical line describes the average energy needs of children one to three years old. The vertical broken lines describe the estimated limits of the variability of the energy requirement (± 2 S.D.). The solid curve represents the dietary protein concentration required to meet average protein needs at the specified energy intake. The broken curved lines represent the limits of variability (± 2 S.D.), the upper representing the safe level of protein intake.*



Source: Payne (reference 16), modified.

If physical activity of these children is depressed because of low energy intake, increased energy intake might result in increased activity and energy expenditure. However, pending a demonstration that this is the case, the existing situation must be taken into account in suggesting safe protein-energy ratios when such communities or groups have been identified.

Payne (*17*) has published an estimate of the levels which may be relevant to such conditions. The 1971 Committee suggested that maintenance energy requirement, which includes only the minimal amounts of energy needed to sustain normal body function and provide for such activities as washing and dressing, is approximately 1.5 X BMR. They also gave estimates of the amount of energy needed to support normal growth in children. The maintenance-plus-growth requirement also has individual variability, which was assumed to be the same as for BMR. For a child at the lower end of this range of energy needs and at the same time having the upper range of protein needs (analogous to point C in Figure 1), the protein-energy ratio would be about 6.9 per cent. As previously noted, the probability of this occurring would be very small.

While the above examples illustrate situations in which the protein-energy ratio might exceed that predicted, it is of interest to note that lower ratios have been reported in populations of short stature but without apparent signs of malnutrition. (*20*).

It is emphasized that figures of the type discussed above were intended for application to the diets of individuals and are not appropriate for comparing to national diets. Beaton and Swiss have demonstrated the problems involved in attempting to do so. The variability of the protein-energy ratio in self-selected diets must be considered; this could be as high as 20 to 25 per cent of the average ratio. By the Beaton and Swiss prediction model, the average ratio would have to be met. In the absence of knowledge about the variability of the ratio, the existence of a high average protein-energy ratio does not give assurance about the adequacy of the diet. Specific information about individual dietaries is needed. This point is made as a caution against application of the simple ratios to national diets. Several participants felt quite strongly that guidelines for national diets were neither appropriate nor necessary, in that comparison of average diets or food supplies to such guidelines should not be encouraged.

All of the ratios discussed above are expressed as milk or egg protein. They are subject to the same adjustments as have been described for the safe level of protein itself.

In summary, for individuals or population groups categorized as having "moderate activity" in the terms used in the 1973 Report, a protein concentration of 5 to 5.5 per cent of energy would suffice to meet the needs of almost all individuals who met their energy needs. Where activity levels are categorized as "light," a somewhat higher ratio would be needed to provide

sufficient protein; similarly, where activity levels are classified as "heavy," a lower level might suffice. Exceptions to this generalization may be the young infant, the pregnant woman and the lactating woman. In the absence of informaton about variabilities and correlations of requirements for these groups, no recommendation about safe protein-energy ratios can be offered; the ratios are unlikely to be lower, and may be higher.

In population groups where energy intakes are unusually low for any reason, protein-energy ratios will necessarily be high if the protein needs of all individuals are to be met. It is to be emphasized, however, that where energy intakes are low and restrict desirable activity or performance, as is the case in many developing countries, the approach should be to increase energy intakes to appropriate levels and not to adjust protein-energy ratios to existing low levels of energy intake. Moreover, it should be recognized that, whenever energy intakes are physiologically inadequate, protein utilization is impaired.

These safe protein-energy ratios are intended only for assessment of the diets of individuals. The levels suggested in this report are not appropriate for comprison with national or average diets; the ratios are too low for that purpose. The underlying assumption that energy needs are met must be emphasized in any application of these ratios.

The participants reiterate the position put forward by the 1971 Committee. The safe protein-energy ratios discussed above are based upon predictions of the concentrations required to meet the physiological needs. Preferred diets in many population settings may provide higher concentrations. There is no connotation that levels should be lowered to those suggested above; rather, these should be seen as a lower limit of acceptable dietary concentration, below which the risk of physiological inadequacy increases.

V. RESEARCH NEEDS

The 1973 Report identified major research needs, and little progress has been made in these areas in the interim. Attention should be given to the following topics, prior to any future recommendations as to physiological energy and protein requirements and dietary allowances of energy and protein.

Possibilities for catch-up growth

Energy and protein requirements for children and adolescents whose weight and height for age are low compared with accepted standards now are based on desirable instead of actual weight for age. The extent to which this estimation is valid depends on the extent to which catch-up growth can occur at various intervals after the initial impairment. There is insufficient evidence on this point and the issue needs to be settled by well-designed prospective studies.

Basal metabolic rates

BMR is a standard which is widely used for a variety of purposes in nutrition. At present, there are few tables available which can be used with assurance to estimate the BMR of particular population groups.

There is much scattered information on BMR in the literature which should be collected and categorized. New data on BMR and other physiologic standards (e.g., 24-hour creatinine excretion, body composition) should be obtained for various national population groups, the sample populations being selected by statistically acceptable methods.

Consequences of physical inactivity

Where physical activity of adults is restricted due to economic factors that limit food intake, adverse socio-economic consequences are apparent. Comparable information is not available for the effects on children of reduced activity associated with enforced energy restriction, but there is suggestive evidence that both growth and psychomotor development may be impaired. It is important to extend these observations for their relevance to acceptable energy intakes for children.

Low levels of physical activity, and hence lower requirements in adults, even when due to cultural rather than economic constraints, are believed to have undesirable consequences for health. This, too, needs much more extensive study.

Effect of climate on requirements

Energy needs. In most tropical countries, reduction of physical activity is the only voluntary alteration that

most of the population can make to cope with higher mean ambient temperatures. There may or may not be a lowering of the BMR. Thus, it is possible that the figures of the 1973 Report slightly overestimate average energy requirements in hot countries. Definitive information is needed on questions of BMR and changes in the pattern of physical activity with shifting ambient temperatures.

In cold weather, people generally adjust their clothing and housing to maintain a comfortable micro-climate. There is a possibility that the figures of the 1973 Report underestimate the dietary energy needs of poor segments of some populations during cold seasons if shelter, fuel and clothing are inadequate. This question should be explored by appropriate field studies.

Protein needs. It is established that nitrogen losses in sweat increase under conditions of high environmental temperature, especially with heavy physical work, but the extent to which this is counterbalanced by a fall in urinary nitrogen excretion is argued. There is need to determine if sweat nitrogen losses under tropical conditions are or are not fully compensated by decreases in urinary nitrogen excretion, especially when dietary intake of protein is minimally adequate.

Seasonal variations. In some populations there are, due to seasonal variations in climate, activity, food availability and other factors, marked seasonal variations in food intake and in body weight. Field research must take into account the possibility of such variability and assess its biological significance.

Nutritional infection and parasitism

Acute and chronic infection and infestation are prevalent in populations of developing countries, especially among young children.

The metabolic responses to acute infection have been well characterized and their association with impaired growth and development has been documented (*21*). There is, however, almost no information as regards the level of energy and protein that can be used effectively during recovery and in intervals between acute episodes. Therefore, the extent to which present recommendations are sufficient to allow for this on a population basis is unknown. Information is needed on the magnitude and duration of anabolic processes leading to retention of energy and protein during recovery and between intercurrent infections in affected populations, and on the question of whether or not intakes of energy and protein above the present requirements figures, based on reference rather than actual body size, bring about more rapid recovery and improved growth.

Morphologic changes occur in the gastrointestinal tract of populations with a high frequency of enteric disease, but the effect of these changes, as well as of ordinary mixed intestinal parasite burdens, on the absorption of protein and other essential nutrients has not been studied adequately. As impaired absorption will reduce the availability of dietary energy and protein, this problem should be studied in relationship to nutritional requirements of affected populations.

Energy intake and protein requirements

Past committees have emphasized that energy intakes inadequate for the maintenance of body weight are associated with less efficient utilization of dietary protein, but insufficient attention has been paid to the fact that energy intakes above the requirement level increase nitrogen retention. To avoid the risk of confounding the interpretation of nitrogen balance studies with the effects of energy deficiency, most investigators have provided liberal energy intakes and frequently permitted some weight gain in adults. The effect of this treatment would have been to minimize nitrogen losses in studies of obligatory nitrogen output and minimum requirements of various dietary proteins and, so, to underestimate the requirement for adult maintenance. There is an urgent need to re-examine protein requirements, using energy intakes normal for the individuals studied.

Moreover, the criteria for adequacy of protein intakes must not be limited to nitrogen balance, but must include also changes in body composition and relevant functional measurements, such as hepatic function and immuno-competence.

When energy intake is deficient, provision of protein without a significant increase in energy intake is unlikely to improve protein nutritional status effectively. Even in these circumstances, however, there is evidence that the extent of nitrogen imbalance in

adults may be influenced by protein quality. However, field studies of amino acid fortification have not generally demonstrated its efficacy. This issue requires further documentation.

Respiratory loss of metabolic nitrogen. Evidence used by the 1973 Committee to justify the conclusion that molecular nitrogen (N_2) does not participate in respiratory exchange was circumstantial. Additional evidence has been offered to suggest that small but significant amounts of N_2 derived from protein metabolism are lost with expired air, but it is far from conclusive. It is important to prove or exclude the possibility of significant metabolic production of N_2.

Factors which limit energy intake. The low energetic density of some diets makes it difficult for young children to consume enough to meet their energy needs. There is a need to determine *a.* the effects of increasing the meal frequency and/or the density of diets, by addition of fat or other means, on the capacity of young children to meet energy needs, and *b.* the minimum energetic density of diets required for this purpose, within the constraints of maintaining adequate protein-energy concentration of the diet. Alternative methods of increasing energetic density of the diet should be examined, including the desirability and feasibility of breeding programs to alter the water-binding capacity or fat content of staple foods, which will result in increased density of foods as consumed, and home processing procedures to accomplish this same objective.

There is also a need to determine the extent to which low intakes of protein or other nutrients, or the presence of other food factors, may limit appetite and hence food intake.

Digestibility. There is insufficient information on the true digestibility of protein and energy in diets consumed by various population groups, considering the full range from vegetarian diets to those with substantial amounts of animal protein and of commercially processed foods. Interpretation of amino acid scores and determination of the net availability of energy and protein require such data.

Protein quality. There is now extensive evidence that NPU, as conventionally measured, tends to overestimate the ability of diets of intermediate and poor quality to meet human needs.

The use of procedures to determine the nitrogen retention response to dietary protein, relative to egg or milk protein, over a range of intakes from just below to just above requirement levels has been suggested as one method for the evaluation of protein quality (*22*). When a number of human subjects are studied in this manner, the amount of dietary protein needed to achieve nitrogen balance can be established within appropriate confidence limits. These data will be needed in any future re-examination of human protein needs.

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Participants

Members: Dr. G.H. Beaton, Professor and Head, department of nutrition, School of Hygiene, University of Toronto, Canada. Dr. J.G.V.A. Durnin, Institute of Physiology, University of Glasgow, Scotland. Mr. P.R. Payne, department of human nutrition, London School of Hygiene and Tropical Medicine, London, England. Dr. R.G. Whitehead, Dunn Nutritional Laboratory, Cambridge, England.

Secretariat: Dr. G. Arroyave, Chief, division of physiological chemistry, INCAP, Guatemala City, Guatemala. Dr. M. Béhar, Chief, nutrition unit, WHO, Geneva, Switzerland. Dr. D.H. Calloway (*Chairman*), Professor of Nutrition, department of nutritional sciences, University of California, Berkeley, California, U.S.A. (*FAO Consultant*). Dr. E.M. DeMaeyer, Medical Officer, nutrition unit, WHO, Geneva, Switzerland. Dr. J. Périssé, Senior Officer, food policy and nutrition division, FAO, Rome, Italy. Dr. N. Rao Muturu (*Secretary*), Nutrition Officer, food policy and nutrition division, FAO, Rome, Italy.

PAG representatives: Dr. N.S. Scrimshaw, Professor and Head, department of nutrition and food sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A. Dr. P.S. Venkatachalam, Deputy Director, PAG Secretariat, United Nations, N.Y., U.S.A.

Books

Single Cell Protein. P. Davis [ed.] 1974. Academic Press, London and New York. U.S. $14.75. 235 pp. and appendices.

This book is the proceedings of an international symposium held in Rome in November 1973, sponsored by the Stanford Research Institute and Liquichimica S.p.A.; a brief report of the symposium appeared in PAG Bulletin, Vol. IV, No. 1. It was the first major conference on SCP held in Europe and took place at a time when many of those engaged in SCP production and regulatory activities were especially interested in aspects of standardization, evaluation and safety of the products. Thus the symposium aimed to supply information in those areas.

The symposium was divided into four sessions: consideration of SCP as a protein source; nutritional evaluation of SCP; current position of SCP—production, standardization and use; and a session of round table discussions. The round table topics were: control of SCP processes, processing of SCP for human food, nutritional value and safety of SCP for human food, utilization and safety of SCP as animal feed, and political and social aspects of SCP utilization. The fifteen papers delivered at the first three sessions are published in full in the proceedings as well as useful summaries of each of the five round table discussions.

The volume also includes as appendices PAG Guidelines Nos. 6, 7 and 15. The first two served as background for many of the papers and much of the discussion at the symposium. Although *PAG Guideline No. 15 on Nutritional and Safety Aspects of Novel Protein Sources for Animal Feeding* did not exist at the time of the conference, significant information that came out of it served as background for the PAG *ad hoc* Working Group that drafted the guideline.

Protein and Nutrition Policy in Low-Income Countries. Francis Aylward and Mogens Jul. 1975. Charles Knight & Company Limited, London and Tonbridge, England. £2.50. 145 pp. and index.

This is an overview of the world malnutrition and protein problems, dealing with protein foods and their sources, supplies and needs in rich and poor countries against a background of national and international recommendations and policies. In simple language it introduces the major nutrition problems and issues on the technical and policy levels and what was discussed, decided and attempted through the 1960s and early 1970s by governments and international agencies. It is above all a useful *aide memoire* for the origins, mechanisms and processes of nutrition-related activities in the United Nations System in the recent past, with an especially extensive account of the work of the PAG.

Food Standards Committee Report on Novel Protein Foods. Prepared for the Ministry of Agriculture, Fisheries and Food (United Kingdom). 1975. Her Majesty's Stationery Office, 49 High Holborn, London WC1V 6HB, England. 75p net. 82pp.

This short but comprehensive report covers a broad range of protein sources and pinpoints those that could be considered novel in the sense of requiring governmental attention in terms of legislation and regulation. The report pays detailed attention to various protein-rich materials from processed soybeans, oilseeds and legumes other than soybeans, plant sources not normally used for human food and from microorganisms including microfungal, yeast, bacterial and algal materials.

The report surveys current and possible future extent of novel protein food usage and delineates approaches to various problems of safety (which take note of appropriate PAG guidelines), nutrition, labelling and composition as well as enforcement of regulations. The report also discusses the use of novel proteins as ingredients in meat products.

Meeting reports

First African Nutrition Congress

Held 16 to 21 March 1975 at the University of Ibadan, Nigeria, this represented the first opportunity for African nutritionists to come together and discuss the nutritional problems of the continent. Present were 135 participants from 23 countries of Africa, an assemblage that included human nutritionists, biochemical nutritionists, agriculturists, food scientists and nutritionists. They came from research institutions, government service, universities and international organizations including the Organization for African Unity, the Food and Nutrition Commission for Africa, International Union of Nutrition Sciences, FAO, WHO and UNICEF.

At the Congress participants found ample opportunity to discuss their research, share information on research interests, learn about solutions to nutrition problems in other countries as well as to work out solutions to common problems. Symposia included discussions on drought in Africa, food production and processing, nutrition and family health, weaning foods, economics and nutrition policy in Africa and the role of extension workers in nutrition. In addition to invited papers for the symposia, more than 50 papers were presented on a range of nutritional topics including food production, prevention of childhood malnutrition in Africa, and laboratory and applied nutrition research projects. The Congress adopted four main resolutions:

1. That each country urgently needs to develop a food and nutrition policy with an executive body to implement it, for without those policies the problems of drought, starvation and malnutrition cannot be solved on the continent. Food and nutrition policies would enable the countries to determine their peoples' nutrition status, agricultural production, manpower needs as well as information on food shortages and surpluses. It is only after this that food reserves realistically can be built up cooperatively and by individual countries. The Food and Nutrition Commission for Africa was asked to give all necessary help to African governments to develop and implement such policies.

2. That nutritionists in each country should come together to form a nutrition society or group that would help the government to develop and effect food and nutrition policy. Such a group would form a forum for discussion of the country's nutritional problems.

3. That regional meetings of such societies should be held every two years to allow continguous countries to develop common solutions.

4. That the African Nutrition Congress Secretariat in Nigeria should ensure continuity until the next Congress convenes in three or four years.

The proceedings of the First African Nutrition Congress will be available in December 1975 from: African Nutrition Congress Secretariat, c/o Prof. A. Omolulu, University of Ibadan, Ibadan, Nigeria.

—A. Omolulu—

Single Cell Proteins: The Needs, Assessment and Regulations

This international seminar was held in Tokyo, Japan, 11 August 1975. Experts from several countries discussed the global status and new developments in SCP and its role in meeting world food requirements. Some 400 attendees came primarily from Japanese industry, government agencies and universities.

The seminar's first session was opened by Saburo Okita, special advisor to the chairman of the International Development Center of Japan. After welcoming remarks he presented an overview of world food problems and economic development, emphasizing the gravity of the food situation and the need for major international action as recommended by the World Food Conference. Jacques Senez, President of the Microbiological Society of France, then spoke of the place of novel resources in regional and national food strategies. Referring first to the expanding

demands for animal protein in countries that are upgrading their living standards, such as Japan and members of the European Economic Committee, he then contrasted critically the characteristics and costs of various protein resources and their present and probable future impact on protein needs. The discussant was Yasuhiko Yuize of the Japanese National Institute of Agricultural Economics who reviewed the protein requirements of Japan and the status of various resources available to meet these needs, including SCP and its current status in that country. Max Milner of the Massachusetts Institute of Technology then summarized information from the U.S. protein resources and research needs study in progress at MIT (see News).

The second session opened with a paper on assessment and development of SCP in the Soviet Union by A. Pokrovsky, Director of the USSR Academy of Science Institute of Nutrition. The paper dealt with protocols for chemical, biological and human testing of SCP products for safety and nutritional quality related to the expanding manufacture and use of SCP for animal feeding in the USSR.

M. Garattini, Director of the Mario-Negri Institute of Pharmacology, Milan, Italy, gave extensive data from toxicological evaluations of SCP from various sources including those grown on hydrocarbon substrates; no significant effect from any toxic factor was identified. D.A. Stringer of Imperial Chemical Industries Ltd., U.K., discussed Dr. Garattini's paper and described toxicological and nutritional testing procedures for SCP materials sold for animal feeding.

In the final session, R. Ferrando, chairman of the Interprofessional and Interministerial Committee on Animal Feeding, France, presented a paper, "Approval and Regulations of Novel SCP for Animal Nutrition in France." Safe and nutritious SCP products for animal feeding are now sold in France, meeting the strict protocols described by Dr. Ferrando.

The final speaker was Nevin S. Scrimshaw, *ex officio* member of the PAG, who dealt with the international recommendations and guidelines for SCP as developed by the PAG. He reviewed the history, development and present application of these recommendations.

In the closing remarks, Dr. Milner said that the symposium presentations encouraged confidence that SCP's role in animal feeding will have increasing impact on the world food supply and that Japan faces a great challenge and opportunity as a country in the forefront of applications and advances in SCP. Dr. Milner pointed out that a variety of useful SCP products are becoming increasingly available, produced from substrates including starch, sugar, whey, cellulosic wastes, methanol, ethanol, methane and various hydrocarbons. He felt the clear conclusion of the seminar to be that all types of SCP for animal feeding, regardless of organism or substrate, are as safe and dependable as more traditional protein concentrates, provided that they are monitored continuously for safety and nutritional quality, using acceptable international standards.

— Max Milner —

News

Meeting

1-8 August 1976, Cali, Colombia. IV International Symposium on Tropical Root Crops. To be held at the Centro Internacional de Agricultura Tropical (CIAT). For information write: Dr. Eduardo Alvarez-Luna, Organizing Committee for the IV Symposium on Tropical Root Crops, Centro Internacional de Agricultura Tropical, CIAT, Apartado Aereo 67-13, Cali, Colombia.

Singapore breast-feeding campaign

The Consumers' Association of Singapore in January of this year launched a breast-feeding campaign. To help implement the campaign a breast-feeding mothers group was formed. Those interested in infant nutrition can obtain materials for use in such campaigns from: International Organization of Consumers Unions, Room 4a, 11 Penang Lane, Singapore 9.

More news on back cover.

PROTEIN-CALORIE ADVISORY GROUP

The Protein-Calorie Advisory Group of the United Nations System (PAG) is an interdisciplinary committee of internationally-recognized experts who advise the United Nations and its agencies on technical, economic, educational, social and other related aspects of global malnutrition problems and the broad programs and new areas of activity needed for combating them. Since its inception in 1955, the PAG has emphasized protein-calorie malnutrition as a primary and continuing threat to the health and survival of infants and young children in the developing countries and has played an active role in promoting the development of novel and locally-available protein resources for the developing world. The PAG also reacts to socioeconomic considerations, trends in world food supply and consumption and the need for governmental initiatives and priorities in dealing with these problems.

The PAG is sponsored by the Food and Agriculture Organization of the United Nations (FAO), The World Health Organization (WHO), the United Nations Children's Fund (UNICEF), the International Bank for Reconstruction and Development (IBRD), and the United Nations.

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The purpose of the PAG Bulletin is to promote the exchange of information on the world malnutrition problem among all those who are motivated to work towards its solution. Published quarterly in English, French, and Spanish editions, it is sent gratis to individuals, institutions, and commercial organizations with an active interest in scientific, technological, economic or social aspects of protein-calorie malnutrition on a worldwide basis.

The PAG Bulletin can succeed in its mission only insofar as it can comprehensively and objectively communicate with its readership. Readers are invited to comment in writing on what they read in the Bulletin. In addition, the PAG Secretariat welcomes suggestions for broadening and deepening the scope of the Bulletin, thereby increasing its usefulness.

Mailing list
Every effort will be made to honor requests to be added to the PAG Bulletin mailing list. In the interests of economy, however, copies should be shared by colleagues or borrowed from libraries wherever possible. Address requests to:

Secretariat, Protein-Calorie Advisory Group of the United Nations System
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News

U.S. protein resource and research needs study underway

A broad-based study of United States protein resources and research needs is nearing completion at the Massachusetts Institute of Technology nutrition and food sciences department, coordinated by former PAG Secretary Max Milner. Principal investigator is PAG *ex officio* member Nevin S. Scrimshaw, and co-principal investigator is Daniel I.C. Wang. The study, "A Comprehensive Analysis of Protein Resources: Present Status, Future Requirements and Research Needs," has been undertaken with funding from the U.S. National Science Foundation program on Research Applied to National Needs.

Dr. Scrimshaw, in a brief description of the study at the 23rd PAG meeting, noted that in view of the close interaction of food, fuel, population, environmental deterioration and other crises, it has become increasingly important to evaluate the potential of production of food, especially of good protein and energy resources. He said, "Planning for the remainder of the century should take into account not only conventional agricultural food production but also identification of the role of foods not conventionally produced and the research needs in this area."

The project thus has been examining critically the status, particularly in the U.S. context, of a variety of resources including grain crops, cereal proteins, livestock animals, legumes, oilseed proteins, aquatic proteins, single cell proteins, leaf proteins, dairy and meat products, roots and tubers, and chemical synthesis of nutrients. Their probable development, economic feasibility and potential utilization in the intermediate term—1985—and the longer term—2000— is being evaluated. Critical assessment is being applied to constraints affecting all the resources including, where applicable, nutritional quality, toxicology, environmental impacts, energy requirements, processing/production costs, genetic potentials, marketing, and legal and regulatory barriers.

The primary objective of the study will be to identify and assign priorities to the research needed to remove constraints affecting development, economic feasibility or increased production and use of the various protein resources. International considerations are being built into the study. A summary report is expected to be published early in 1976, while the full detailed study will become available some months later.

News continued on page 44.